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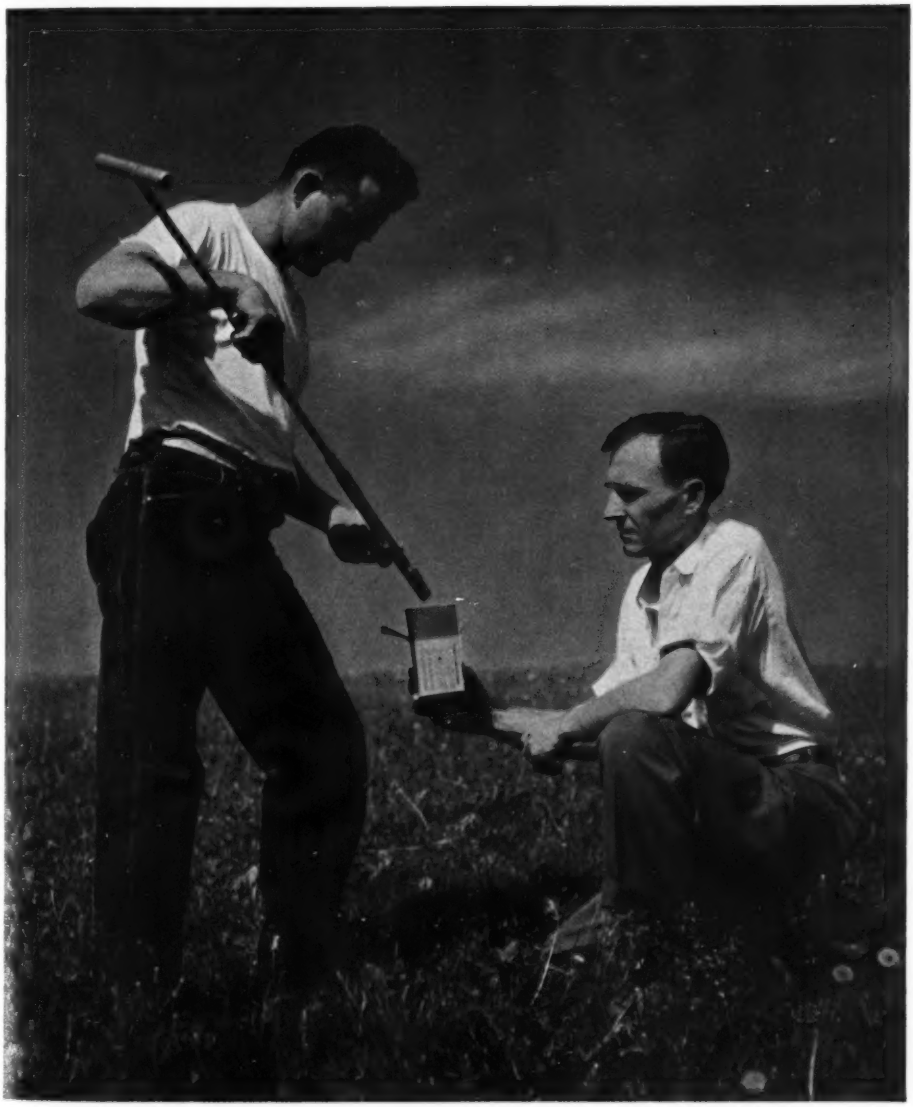

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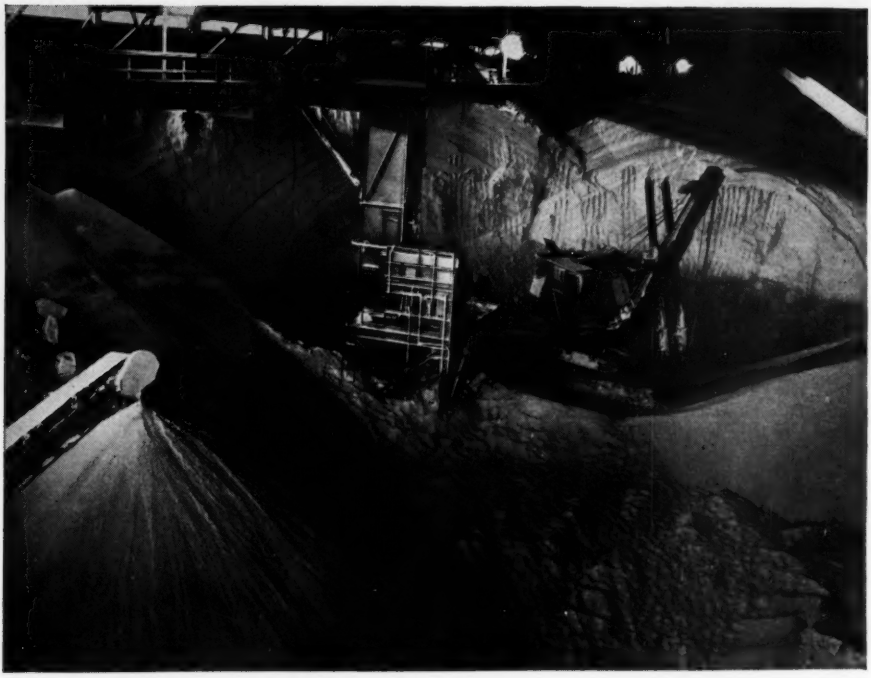

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THE AMERICAN POTASH INSTITUTE

1102 Sixteenth St., N. W. Washington 6, D. C.

Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

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After an Old Pattern!

Better Crops with PLANT FOOD

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VOL. XXXVII WASHINGTON, D. C., OCTOBER 1953 No. 8

Science Improved . . .

Corn and Kine

Jeff McDermid

IMPROVEMENT in the type and production of corn and the livestock that turn corn into milk and meat has been a fascinating and a rewarding game. While most of the best of it has been done by highly trained scientists at the State Colleges and the U. S. Department of Agriculture, we are obliged to acknowledge that the proving-ground for the successful trials of these superior products of agronomists and geneticists has been right on the farm.

If we had had a mass of unwilling and stubborn farmers and stockmen to deal with in the past century, few of the rapid advances would have been possible. In the earliest settlements the immigrants from overseas brought with them seed stock of considerable value, to apply in their conquest of a new and a raw land. As time went on and soils began to lack pep and reserve elements, these men realized that even the best of the living germs of plant and animal resources which they had fostered were not good enough to last.

With the slow establishment of the agricultural research centers it became feasible for these adventurous farmers to seek public aid in the improvement of what they and the Indian natives had managed to secure without the advantage of project papers and scientific exchange of results. Down to the present we can say without challenge that the corn-breeding experiences of the past 30 years are so productive that their effects are likely to be felt even more in the field of livestock breeding than in plant breeding itself. The newer method of corn breeding involves the producing of a fresh supply of seed each year by what they call "controlled heterosis." Some breeders believe we

can modify this method used for corn to make advances in the improvement of many types of livestock.

To begin where we should, note that today we have been collecting thousands of types of aboriginal corn in parts of the American tropics and bringing them to breeding centers for intensive study. Some of these queer, multicolored, and rather nubby native maizes may yield some real genetic secrets. In the day they were produced they no doubt represented a real advance over the first feeble fruits of the corn plant known to mankind in Mexico and Central America. Our Iowa corn breeders are not sneering at the looks of these old Aztec ears. One might just as well make fun of a grub before it soars away as a butterfly.

NOBODY knows, and probably never will know, how the early Indian corn growers worked out their breeding systems. They did a remarkable job with the means at their command. There is proof that the Indians often mixed up religion and votive ceremonies with their corn planting and seed harvesting. Some tribes must have saved their seed because its color arrangement had some significance. Observers say that Indians seem to have had a fancy for the early eight-row strains of flint and flour corn. White people growing corn in the same latitudes seldom use these kinds now.

Breeders believe that the tribes living in the Appalachian and Ohio Valley regions grew dent corn with 16 to 24 rows. Shoe-peg corn with deep, narrow, and rough kernels, sometimes with 24 rows to the ear, was also produced by Southern Indians. These starchy specimens were believed to attain a test weight of 50 pounds per bushel. The eight-row flour corn and the gourd type corn were soft varieties and the natives liked them well because their grinding was easier with the home-made stone mortars they often used to make meal. For roasting ears, evidence tends to show that the aborigines favored the flints. Our museums in the Midwest and Southwest trace the corn lore of the red man for us and give us a new zest for the whole panorama of progress in developing modern *Zea maize*.

Corn Belt enthusiasts often aver that the white farmer greatly improved the corn which the Indian gave him. The Midwest Indians when settlement by white men occurred were growing as a rule eight-rowed flints and flour corn. This was an early-season corn and consisted of white, blue, red, and calico variegated corn. But if the corn that the white man grew in the 1850's was superior in yield to that used by Corn Belt Indians, it is likely that the settlers merely brought with them from the East a later-maturing type of dent corn which had been developed by the red brethren in Pennsylvania and adjacent areas.

If this is true and the white man received a better kind of seed corn from the East than he found Corn Belt native tribesmen using, one wonders just how the better-yielding dents grown by Pennsylvania Indians were produced. Much as he likes to brag, the white man can't claim he had much to do with originating dents—even though he did more fully utilize their possibilities as years went by.

REFERENCE is often made to statements preserved from the records of John Lorain of Pennsylvania, a worthy and respected authority in farming who was a keen student of Indian corn. This man tells us that Indians deliberately crossed the primitive white gourd corn seed and yellow flint and then selected segregates that turned into what we know as dent corn. Whether these first crosses made in the East were conscious ones or just accidental occurrences, the chances are that therein the continent got its first dent corn types.

What happened afterwards stems from the natural results of white men's invasion of a primitive land, with their

own needs uppermost. They brought choice livestock with them—at least in in their own eyes—and wanted corn for cattle, hogs, and horses. They had better grinding outfits than Indians possessed, and so yield rather than softness was the criterion they sought. Here is it that the paths of the tribes-

men and the white invaders drew apart. From that point onward the white man was on the track of something better.

But even up to the late eighties farmers had not done much more than the Indians in corn breeding, except they had substituted a later type of dent corn for the earlier types of soft calico corn their red neighbors had raised. With the challenge that they needed better corn and that they had not actually produced corn very much better than the legacy left by the Eastern Indians, something different had to be done.

First of all, they had to organize and get up steam. No better place to do this, they felt, than to show nice, even, well-rounded ears of corn at local and state fairs. I remember that era well. Every fair had its boxes of exhibit corn laid neatly in white and yellow rows, surrounded by farm folks eager to see its beauty and uniformity, and see the anxious judges lift out, examine, prod, and use the jackknife to these ears of open-pollinated maize.

Beauty shows they were, to be sure, maybe not with the genetic possibilities for inheritance now possessed by the beauty contests where we gawk at feminine pulchritude. Beauty was the key to praise and prizes in those corn shows at the turn of the century and up to the 1920's. Colleges held them at midwinter short-courses and farm boys trained in judging teams later became growers of fancy ears selected carefully for the autumn shows. They did much good even if beauty was not the right approach to yield and feeding value. The corn shows focused everybody's eyes on maize as it had never been glorified before. Trips to Washington for the boys' corn clubs further stirred up the latent enthusiasm of young men for doing something or other to what had long been neglected.

SUPERFICIAL appearances led to no overwhelming improvements, but the spark that finally lighted the train of circumstances most assuredly was struck in that era of admiration. One of the pioneer corn revivalists and champions was the late Perry G. Holden of Iowa State College, a teacher and extension agronomist. I often heard him lecture in college halls between 1913 and 1920. In his student days at Michigan State College, Mr. Holden had learned to respect the botanical theories of Dr. W. J. Beal. Beal was the first man to hybridize corn to produce vigor in the first-generation hybrid.

Holden and his contemporaries had more faith in boys and their ambitions than they did in the selection of pretty corn. Some of them got interested enough in measuring the value of the beauty-show corn through use of the ear-to-row tests. If they were convinced, after making numerous trials of this nature with the choicest show ears to be found, that there was little

(*Turn to page* 50)

More Effective Fertilizer Use Needed in the Northeast

By Mack Drake

Massachusetts Agricultural Experiment Station, Amherst, Massachusetts

FERTILIZERS traditionally have played an important role in crop production in the Northeastern States.[1] The land in this region was in forest when the first settlers came. In this region a layer of organic matter 8 to 12 inches deep accumulated from leaves, branches, and the trees themselves.

The forests were cleared and early writers described how easily the land plowed and what bountiful crops were produced for the first few years. Under the cropping systems used, little organic matter was returned to the soil. Plowing and tillage increase the aeration of the soil and increase the rate of organic matter breakdown, much as opening the draft of a furnace increases the rate of fuel consumption.

After a few years the thick layer of organic matter and its reservoir of nitrogen, phosphorus, potassium, and other plant nutrients was greatly reduced. Many of the soils of the Northeast were low in phosphorus- and potassium-supplying minerals and were low in lime. Liming became an accepted practice. Manure produced excellent crop yield responses but there wasn't enough manure. By 1700 many farmers were using fish, fish scrap, tankage, and wood ashes as fertilizers. Farmers in New England continued to buy wood ashes from Canada in carload lots as late as 1900. It has been said that the fertilizer industry started in New England.

During recent years more and more fertilizers have been applied, particularly on land for vegetables, potatoes, and other crops with high acre values. As indicated by recent research, considerably more fertilizer is needed each year to reach a high level of crop production on most soils in the Northeast. Fertilizers are not being used to their maximum efficiency on some crops. Certain changes in methods of fertilizer application, in amounts of lime and nutrients used on different crops, and in farm management practices can improve the effectiveness and efficiency of fertilizer use.

Why is more effective use of fertilizer materials needed?

As natural soil fertility is depleted, and as world food requirements increase, more and more fertilizer materials will be needed. Since the potential need for fertilizers far exceeds the supply, our farmers must be encouraged to make the most effective use of the present production of fertilizer materials.

What is the relative effect of increasing or decreasing the amount of nitrogen, phosphorus, and potassium (N-P-K) on the yields of important crops? Figures on fertilizer use and data from hundreds of fertilizer experiments from all the 48 states were assembled in 1951 through the cooperative efforts of a

[1] Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, and West Virginia.

large number of state and federal agronomists (7). These data indicate the possibilities of much larger crop yields and more efficient crop production through the wise use of fertilizer. They show the serious decreases in crop yields that would result from sharp reductions in current fertilizer usage. Many soils throughout the Northeastern region would not produce marketable crops without the liberal annual applications of complete fertilizers.

Major Crops in the Northeastern Region

Dairying, general livestock, grain, and fruit, vegetable, potato, and tobacco growing are important types of farming in this region. Forage crops, corn, and small grains are grown on both general livestock and dairy farms. More than 65 per cent of the farm land in this region is in rotated or permanent hay and pasture. Many farms, especially in the six New England States (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island), have replaced substantial acreages of corn silage with grass silage. Acreage of superior legume-grass mixtures has increased. This acreage increase will become more rapid as more and more farmers learn the principles of fertilization and grazing management required for superior legume-grass mixtures.

Climate and Soils

Most soils of this region are acid and are low in natural fertility. Rainfall distribution and temperature are favorable for production of vegetables, potatoes, small grain, and forage crops. However, many of the soils are low in water-holding capacity so that supplemental irrigation is needed for maximum production of many shallow-rooted crops.

Fertilizer Usage

The historical as well as the present average use of 8 pounds N, 20 pounds P_2O_5, and 13 pounds K_2O per acre (Table I) is much higher in the states of the Northeastern region than in the North Central or Western regions (7). However, even these values are misleading. Many intensively cultivated crops as tobacco, vegetables, and potatoes receive very high applications of fertilizer. Corn and small grains and limited acreages of improved forage

Fig. 1. A Vermont pasture in the rough. With little expense, such pasture can be brought to a high state of production by the intelligent use of lime and fertilizer.

mixtures receive moderate applications of fertilizer. But a large acreage of hay and pasture receives very little fertilizer.

TABLE I.—AVERAGE USE OF N, P_2O_5, AND K_2O FOR THE MAJOR FERTILIZER-USING CROPS IN THE NORTHEASTERN REGION IN 1950 (7)

Crops	1000/ Acres	Pounds per acre N	P_2O_5	K_2O
Corn Grain	3,194	14	34	20
Corn silage	142	11	29	14
Wheat	1,880	10	42	22
Rye	315	6	26	16
Barley	344	9	40	17
Oats	2,079	6	31	14
Soybeans	202	2	27	23
Tobacco	119	76	79	130
Potatoes	472	83	156	178
Vegetables	823	68	129	92
Fruits	640	20	10	9
Legume grass	10,295	1	7	4
Perm. grass	12,868	3	5	2
Average all crops*	33,373	8	20	13

**Manure.* It is important to recognize that on dairy and general livestock farms a large amount of the plant nutrients (nitrogen, phosphorus, and potassium) come from manure. Although the surveys did not include the yield responses to manure, it is generally recognized that a pound of N, P_2O_5, or K_2O from manure is as effective as a pound from inorganic fertilizers.

Experimental crop yield results produced by N-P-K fully justify increasing and current acre applications to nearly all crops, particularly forage in the Northeast. However, more is required than simply dumping on additional fertilizer. Such problems as the supply and availability of straight materials to farmers and the added cost of more fertilizer must be considered. Lower handling cost of high analysis fertilizers should reduce the unit cost of N-P-K to the farmer. More effort must be placed on finding more effective ways to use the fertilizer we now produce. For example, a farmer should not be forced to buy a complete fertilizer if his alfalfa requires a topdress application of straight potash. Likewise, a vegetable grower should not be forced to use an 8-8-8 or similar complete fertilizer for sidedressing if his crop needs N and K.

Why are liberal applications of fertilizers required in the Northeast?

Nitrogen. Most of the soils of this region now are low in organic matter. Relatively high rainfall especially during the fall and spring causes serious annual loss of nitrates by leaching. Many of the soils are low in lime, phosphorus, and potassium so that grasses crowd out legumes to the extent that many areas are referred to as "natural grasslands." Legumes are inadequate in this region as a source of nitrogen for all types of farming if maximum levels of production are to be achieved. With many intensively cultivated crops such as vegetables, legumes can supply only a small part of the nitrogen requirements. Even with legume-grass associations varying amounts of applied nitrogen are needed for maximum production, particularly in establishing new seedings on soils low in available nitrogen, and in meadows where there is a low ratio of legume to grass.

Phosphorus. For many years farmers in the Northeast have made heavy applications of available phosphorus to areas in potatoes, vegetables, and other high acre-value crops. Experimental data show that on many soils of this region crop yield response continues to high levels of applied phosphorus. But recent research shows that plants often recover less than 10 per cent of the fertilizer phosphorus applied in a growing season. Why is this recovery so low?

When soluble or available phosphorus is applied to soils of the humid region, much of that phosphorus reacts with active forms of iron and aluminum in the soil to form relatively unavailable iron and aluminum phosphates (1, 2, 6, 9). These compounds have been identified recently as strengite and varascite (3). Soils of the Northeast are much higher in active iron and aluminum than soils of other regions (1). This helps explain why much larger applications of phosphate fer-

Fig. 2. The spots in this pasture speak eloquently for the value of nitrogen and potash—the principal constituents of urine. The herbage on such spots is not too palatable unless the N and K are balanced with lime and phosphorus and the herbage maintained in succulent condition by careful grazing and clipping.

tilizers are required by soils of this region to supply a given level of available phosphorus to plants.

Soil organic matter increases the effectiveness of applied phosphorus

Farm practices which increase the efficiency of utilization of applied phosphorus are of great importance. In the humid region increased effectiveness of applied phosphorus can be attained by proper use of manure, sod-forming crops, and crop residues. In the decomposition of organic matter by micro-organisms, organic compounds such as citric acid are produced. The organic compounds inactivate iron and aluminum, forming stable Werner type complex ions (9). In this way organic matter is highly effective in reducing phosphate fixation and in releasing phosphorus from fixed iron and aluminum phosphates (4). This release of relatively insoluble phosphorus by the products of microbial activity is believed to be the most important mechanism which reduces the reliability of chemical soil tests for available phosphorus. Furthermore, because of this effect of organic compounds in releasing fixed phosphorus during the growing season, the attempt to increase the accuracy of chemical soil tests for available phosphorus is unrealistic. For example, frequently, it is found that in March or April a soil test is low in available phosphorus, yet if there is organic matter present and a liberal amount of nitrogen is supplied, there is no crop yield response to applied phosphorus. It is believed that in this case adequate amounts of phosphorus were made available when released from "fixed" iron and aluminum phosphates by the increased production of certain organic compounds. And in this region the amount of phosphorus from the organic matter itself is quite small as compared to that released from inorganic sources!

In the Northeast the established practice of using superphosphate in the dairy gutter and on manure reduces phosphorus fixation to a minimum. For this fundamental reason the fertilizer industry is urged to make superphosphate available to the dairy farmer. Banding and pelleting superphosphate

reduces physical contact with the soil, thereby reducing fixation of phosphorus.

The practice of sidedressing cultivated crops with a complete fertilizer must be condemned as an inefficient and wasteful use of phosphorus. In addition to practices which reduce phosphorus fixation, some major shifts in phosphorus use by crop should be made.

Potassium. Many soils of this region are low in cation exchange capacity, and the soils are low in potassium-supplying power. Soils of this region do not receive an annual deposit of potassium bearing loess as do many areas in the Corn Belt. On these soils, low in available potassium and low in potassium-supplying power, a large part of this element required for adequate crop production must be supplied as fertilizer potash. Fundamental studies on the mechanism of cation uptake by plants are helpful in understanding why two or three split applications of fertilizer potash are required, particularly for high production of superior legume-grass mixtures and for certain vegetables (5). In case of crops requiring a high level of available soil potassium throughout the growing season, split applications of K reduce luxury consumption of potassium thus making for more efficient use of this nutrient element.

Lime. Nearly all soils of this region are acid and require periodic applications of limestone for most crops. Lime is essential for the efficient utilization of all fertilizer elements on most soils. In the case of sandy soils (low clay) when limestone is ground too finely, much of the calcium and magnesium is lost by leaching. Thus it is reasoned that on sandy soils 20-40-mesh limestone may be more desirable than 100-mesh stone.

Yield response curves for N, P and K

In general, the yield response curves for the major fertilizer-using crops are similar and the response to additional N, P, or K depends on where current use of that element falls on the yield curve. For example, Irish potatoes received 156 pounds P_2O_5, and vegetables received 129 pounds P_2O_5/acre (7). These high rates of phosphorus application fall on the flatter part of the curve and changing the current rate would produce small changes in yield. In contrast the average use of 7 pounds P_2O_5 on improved legume-grass mixtures is very low and falls on the steep part of the curve. Here any important changes in phosphorus application will produce major changes in forage crop yields. Use of N and K on forage crops in the region is also low and like P falls on the steep slope of the curve. Hence forage crop yield response to N and K is also high.

Yield Potential of Forage Crops in the Northeast Is Tremendous

The largest potential expansion of fertilizer use in this region is on forage crops. The survey shows that throughout the Northeastern region tremendous increases are possible in the production of forage by the adequate fertilization of superior legume-grass mixtures such as alfalfa or ladino clover with smooth brome or leafy late-maturing strains of orchard grass. Adequate fertilization of areas now in permanent grass will likewise produce large increases in forage yields. An increased production of high quality forage is needed in the Northeast to help the dairy industry lower production costs and to help milk production keep pace with our growing population during the next 25 years.

The annual average use of fertilizer nitrogen on permanent grass in the 12 Northeastern States is only 3 pounds per acre on 12 million acres (7). If on 6 million acres of this land, the rate were increased to 40 pounds of nitrogen per acre, with adequate phosphorus and potash and best management, the yield would be increased over 50 per cent. This increased production would be equivalent to the production on an added 3 million acres; however, this would require 110,000 additional tons

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Cattle and the Farm Economy of the South

By Paul F. Newell

Mississippi State College, State College, Mississippi

AS systems of farming shift and change in this area and as more land becomes available as a result of shrinking acreages in row crops, the beef cattle business assumes more importance. This is true because lands removed from crop production are best employed when used for grass and forage production and because these are the types of feed crops that are well utilized by cattle. Beef cattle production is a land-use type of business and money returns are figured on a volume basis rather than on intensive methods. The expanding acreages in forage crops fit this enterprise to advantage.

The cattle business provides a profitable market for grasses and feeds produced on the farm that otherwise would not be readily marketable. If this principle were better understood, fewer pastures would be overstocked and stored feed supplies would more nearly fill the needs for wintering herds. Grass, roughage, and grain production are basic to the management of cattle on each farm. But to grow grass is not to set up a system of farming. Cattle production is much more than that.

Cattle production conserves and improves the land. Much of the profit

Fig. 1. Good cow herds are more profitable in a cow-calf plan.

from cattle is returned to the land and the herd. This practice enlarges the capital resources of the business and its earning power. That's what gives the cattle business the high prestige and stability it enjoys on many farms in all sections of the country.

Beef production is an enterprise which challenges each operator to increase his cattle income by improving his methods. The opportunities for success are greatest in this area when the business is built around a good cow herd and preferred market outlets that go with such a business.

Wise buying and selling methods and good production technique are both part of the cattle business. Any successful producer will, if he understands practical economics, have many opportunities to take advantage of supply and demand situations which he can turn into profit for himself. To sell cattle when they are "ready" and when they will bring the highest dollar and to buy when they are the cheapest is an important principle to be observed by the cow man.

The Cow-Calf Plan Is Basic

The cow-calf phase is the heart of the commercial cattle industry in the South. It is the type of operation suited to most farms. It's a long-term business but it's safe. Few go broke who give their cow herds reasonably good management. Labor requirements for the cow-calf business are less than for most other types of livestock business.

The cow-calf operator must provide a dependable grass supply for a long grazing season. The beef herd requires pastures that will furnish grass on an economical, dependable basis. That's why permanent and perennial types of pastures are basic to the cow business. The steer man and other classes of livestock producers can use rotation pastures; there's little place for them in the cow-calf operation. Annually planted pasture crops will not sustain a cow-calf business. When short-term spring pastures mature, they

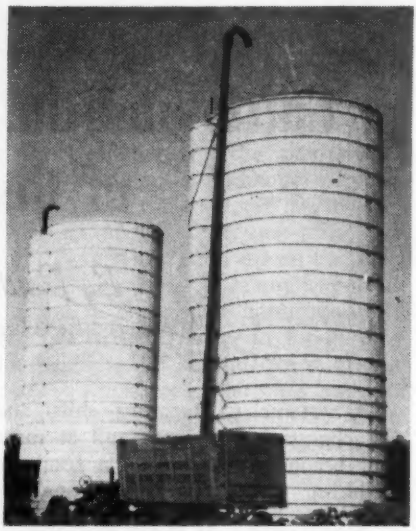

Fig. 2. The silo is becoming a more important factor in Southern beef production.

fade away to leave little grass on the land in the summer and fall when the grass supply is usually short.

The cow-calf operator stocks his permanent pastures moderately, allotting enough land for the herd to insure a reserve of forage on the ground at all times. He fertilizes his pastures as needed but never plows a permanent sod. He mows as needed to control weeds, never to remove good forage. That is left for the cattle. The weather is usually dry in the summer and fall, and this reserve supply of grass often is the difference between a profit or a net loss.

Winter Feeding Necessary

The necessity for feeding for 70 to 90 days in the winter cannot be overlooked. All cattlemen have to feed in the winter. Silage and hay are essential feeds in the winter management of the cow herd. Pasture is not dependable as the winter feed supply for the cow-calf operator. It can supplement other feed. Silage is the basic roughage for large producers because it is impracticable to grow enough hay on an average farm to winter a large herd.

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Sampling Soils for Chemical Tests

Prepared by J. F. Reed, Atlanta, Georgia, together with Members of the Soil Test Work Group of the National Soil and Fertilizer Research Committee [1]

UNDOUBTEDLY one of the most important issues associated with soil testing is the matter of obtaining a soil sample that represents the area to be tested. The Soil Test Work Group encountered the problems of proper soil sampling when surveying the status of soil testing in the United States. It was observed that a large number of different agencies are involved in taking soil samples. Although almost all of these agencies recommend taking a composite sample, the suggestions for doing so vary considerably.

It was the recommendation of the Work Group that summaries of existing data be made and studies be conducted on procedures for adequately sampling fields. However, pending further research studies, it should be helpful if some procedure which would incorporate the best features in existence could be set up as a "general" procedure. This, of course, would be subject to modification for local use, but would offer some basis from which to work. The preparation of such a procedure has been the purpose of this study.

It must be acknowledged that the subject of soil sampling is not one upon which considerable research work has been done. Much of what has been done is not published. This makes the task of setting up a "reference" soil-sampling procedure difficult. In preparing this suggested procedure, the Soil Test Work Group has solicited advice from many agronomists, and advantage of the best information available, both published and unpublished, has been taken. A partial list of the literature dealing with soil sampling is appended to this article.

The instructions for soil sampling to follow are based on the type of procedure involving a composite sample from a given area. This is the sampling method in use by almost all states in this country. A different type of procedure is recommended in Illinois and there is certainly much to be said for their method. It is not the purpose of this article to discuss the merits of the two plans but rather to attempt to set up a standard or "reference" procedure for those who use the single composite method.

Instructions for Taking Soil Samples

1. For the purpose of sampling, the farm should be divided up into areas or fields not larger than 5 to 10 acres each. If an area or a field is very uniform in appearance, production, and past treatment, it may include as much as 20 acres. However, areas that are different in appearance, slope, drainage, soil type, or past

[1] The Soil Test Work Group is composed of: Southern Region: J. W. Fitts, N. C. State College, Chairman; North Central Region: J. J. Hanway, Iowa State College; Northeastern Region: L. T. Kardos, Univ. of New Hampshire; Western Region: W. T. McGeorge, Univ. of Arizona; U. S. Department of Agriculture, L. A. Dean, BPISAE; Industry Representative: J. F. Reed, American Potash Institute.

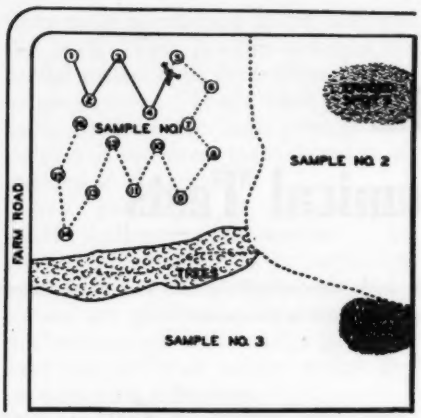

Fig. 1. In a non-uniform area, as shown above, sample No. 1 would include level upland, No. 2 would be taken from a sloping area, and No. 3 from bottomland. Each sample is made up of 15 to 20 borings taken as in sample No. 1 and put in a one-pint carton.

treatment should be sampled separately even though smaller than 5 to 10 acres.

2. The diagram shows the method of properly locating the areas to be sampled. Take a separate composite sample for each soil area or field. In taking samples a soil tube, soil auger, or narrow-bladed trowel are preferable, but with proper precaution a satisfactory sample can be taken with a spade and knife.
3. Avoid taking the sample from the fertilizer band when sampling fields in row crops. Avoid any unusual spots such as old fence rows or roadbeds, or where lime or manure has been piled or spilled. Also avoid small areas that are much different from the rest of the field. If desirable these areas can be sampled separately.
4. The soil is easier to sample when its moisture condition is suitable for plowing. Even though the soil is too wet to plow, it can often be sampled unless it is too muddy for handling. The best time to sample is after plowing in advance of expected lime and fertilizer applications.
5. Any clods or lumps should be broken up before they dry out. Fairly wet samples can be spread out to dry at room temperature on a clean sheet of wax paper. Don't dry samples on a stove or radiator.
6. Take a uniform core (or thin slice) of soil from the surface to the plow depth (usually about 5 to 6 inches) in from 15 to 20 spots over the field. (In permanent pastures or lawns, sample only to a depth of two inches.)

   If a spade and knife are used, dig a spadeful of soil to the plow depth and throw it aside. Then dig a one-half inch slice of soil and keep it on the spade. Use the knife to cut from this slice on the spade a one-half inch core from top to bottom and place it in a clean bucket or container. Repeat this at each of the 15 to 20 spots.

   If using a sampling tube or soil auger, it may be possible for the amount of soil from each spot to be such that a pint carton will hold the soil from 15 to 20 spots. If this is not practical, such as with the spade,

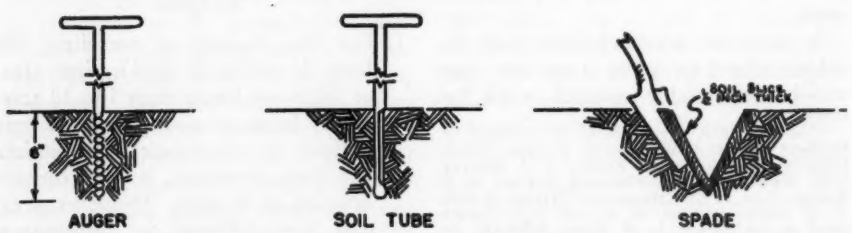

Fig. 2. This shows method and depth of taking a sample with soil auger, soil tube, and spade.

collect in a clean bucket, mix well the soil from all spots, then halve or quarter as necessary to fill a pint carton.

7. Label each sample with a number and your name. Be sure to keep for yourself a record of the area from which the samples were taken. One way is to make a rough sketch or map of the sampled areas.
8. Fill out the information sheet as fully as possible. This will help greatly to make your report and recommendations useful to you!
9. Alkali areas are quite numerous in some localities.* Since alkali salts move up and down in the soil with the moisture, these areas should be sampled in one-foot layers to a depth of three feet or to the water table if encountered at a shallower depth. A soil auger can be used and composite samples obtained for each one-foot depth, in a manner similar to that used for surface soils. In addition a sample of the surface crust itself should be taken and submitted for analysis.

Discussion of Soil Sampling

There are several factors that have to be taken into account in preparing to sample a field for soil analysis. In this discussion some consideration is given to each of these factors to explain and to supplement the instructions for taking soil samples as presented here.

Some agronomists feel that the shortcomings of the existing procedures are not as much a factor in soil sampling as is the difficulty in getting farmers to follow the procedures. Undoubtedly there exists a need for more emphasis on care in sampling and a need for more method demonstration by experienced agronomists. It is recognized that the human factor cannot be eliminated by a "reference" method of soil sampling. Yet the great variety of instructions available certainly contributes to the difficulty in educating agricultural workers and farmers in proper soil sampling. Some uniformity in procedures would help to overcome this.

Among the factors that have to be considered in preparing to sample a field for soil analysis are:

(1) The decision as to the area to select for soil sampling, i.e., what size area to sample, whether to subdivide the field into smaller fields.
(2) The number of borings, the distribution of the borings, and the relation to the size of the area to be sampled.
(3) The sampling tools to be used.
(4) Depth of sampling.
(5) The size of the final composite sample (one pint usually) and whether this should result

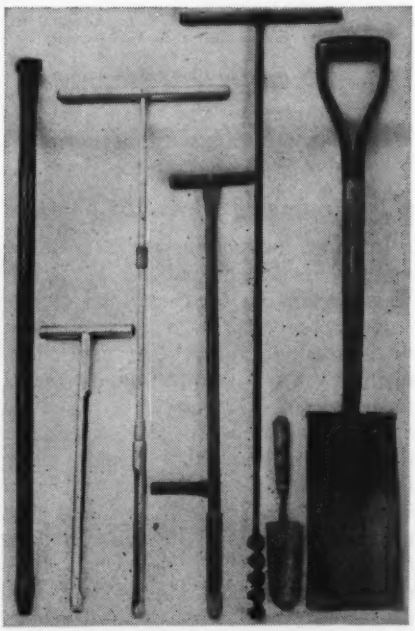

Fig. 3. Various tools can be used to sample soils. The four on the left show some of the soil tubes in use. The one on the extreme left is completely enclosed while the other three have one side cut away. Other tools shown are a soil auger, a trowel, and a spade.

* For possible inclusion in Western areas.

Fig. 4. Here a soil sample is being taken with a soil tube. The sample has been taken to a depth of six inches and this process will be repeated at 15 to 20 places over the field.

from subdivision of a larger sample.

(6) The moisture status of the area —is it too wet or too dry?

(1) Selection of Area to Be Sampled

In most instructions the area to be sampled is designated as a "field." This implies an area confined to one crop or bounded by a fence, stream, ditch, road, or some other line. Frequently the instructions suggest that a separate composite sample be taken for every 5 to 10 acres—thus restricting the size of the field. Actually there is no good basis for such a restriction and more properly soil type and past management should be considered in deciding the size of the area. It is conceivable that a 20-acre field relatively uniform in soil type and in past management could be sampled better as a unit than a 5-acre field that varies in topography, degree of erosion, soil type, treatment, etc.

From a practical standpoint it may be argued that there is little to be gained by dividing a 5-acre field for sampling if the field is to be fertilized or limed as a unit. There is, however, the advantage that some information is obtained on the variation within the field.

Some farmers may prefer to concentrate their sampling sites in the poorer parts of the field. Then the entire field can be treated so as to bring these poorer areas up to maximum production, even though the better areas may receive a slight excess. In still other instances both good and bad areas within a field may be sampled separately in an effort to find out by comparison the cause of these differences within the field. Thus the purposes for which the samples are taken will influence the selection of the area to be sampled.

Admittedly the usual instructions dealing with field size are conservative

in that they both restrict the size of the area represented by one composite sample and specify the omission or separate sampling of smaller areas that differ in topography, position, or past management practices.

(2) Number and Distribution of Borings

Some studies of this type have been published; other unpublished data have been examined or discussed with those who obtained it. Most instructions call for a composite sample made up of anywhere from 5 to 20 borings within a given field. If the field is subdivided because of differences in soil type, another composite made up in the same way is called for.

The exception to this is typified by the instructions given by Illinois where several samples are taken at different locations in the field (e.g., seven locations for a 10- to 20-acre field and eleven locations for a 40-acre field). At each location a composite is made of five different points within a square rod area. Each of these various composites is numbered and analyzed separately, permitting a diagrammatic representation of the results of the soil test on a map of the field.

There are certain advantages of this procedure. It involves a set pattern and avoids the decisions necessary with a variable sampling pattern. It tends to avoid personal bias as to what is a "uniform" area, and also decisions involving separation on the basis of slope, appearance, drainage, etc. It provides a study of chemical variations within the field.

On the other hand the single composite sample of a field is in use by the great majority of states and it is more widely understood. More research studies are published on this method. It involves fewer samples for

Fig. 5. A soil auger is a useful tool for soil sampling. The sampling is taken to plow depth and other borings will be taken at 15 to 20 places over the field to make up one composite sample from the field.

analysis from a field and lends itself to simpler interpretation. The "reference" method outlined earlier is an attempt to standardize the writing-up of a sampling procedure for the single composite method and involves a suggested set of instructions to be used by those who are interested in that method. There is no suggestion that the single composite sample has been proven a better or more correct procedure.

(3) Sampling Tools

A great variety of equipment is used for sampling soils. To a certain extent this will continue to be true, for some tools lend themselves better to sandy soils, others to clay soils, and still others to wet or dry soils. Some are useless where many rocks are in the soil. Even so, it would be tremendously helpful if some uniformity in sampling tools were effected.

With many tools it is almost impossible to sample from 15 to 20 places in a field, getting approximately the same volume of soil from each location or "boring," and confine the total sample to a pint or even a quart. Taking a large sample in the field and then dividing it on the spot into quarters or less introduces the possibility of appreciable sampling error. Hence the "ideal" sampling tool should:

(a) Take a small enough volume from each spot or "boring" so that 15 to 20 borings of equal volume could be put into a pint-sized container.

(b) Be structurally constructed so that it is durable and resists bending, twisting, breaking, or blunting in hard or rocky soil.

(c) Be easy to clean and rust-resistant.

(d) Be adaptable to dry, sandy soils as well as to fairly moist,

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Fig. 6. If other tools are not available, a satisfactory sample can be taken with a spade and a knife. In this picture a ½-inch slice has been taken with a spade to the plow depth. (See Fig. 7)

Some Relationships Between Leaf and Soil Potassium in New Jersey Apple Orchards

By R. L. Wehunt and E. R. Purvis

Soils Department, Agricultural Experiment Station, New Brunswick, New Jersey

INTEREST in potassium fertilization of apple orchards has increased as a result of recent reports of "leaf-scorch" from several apple-producing areas of the United States. Symptoms of this disturbance are similar to those of potassium deficiency in other crops. Leaves lose their bright color, and scorched areas develop at the tips and along the margins. The older leaves are affected first. Apple trees may suffer from incipient potassium deficiency, as with that of other nutrients, long before leaf scorch symptoms appear.

In some areas apple trees are fertilized with nitrogen alone, but use of a complete fertilizer has been standard practice in New Jersey for many years. Because of this complete-fertilizer program, instances of leaf scorch resulting from potassium deficiency are restricted almost entirely to abandoned orchards. Little information is available regarding the possibility of incipient potassium deficiencies in New Jersey orchards.

To obtain data bearing on this subject, and also to study the relationship between available potassium in the soil and the potassium content of apple leaves, an extensive survey of New Jersey orchards was conducted in 1951. Topsoil and subsoil samples were collected from 78 commercial orchards distributed throughout 14 New Jersey counties. Separate samples were taken from beneath the limb-spread of trees and from the row middles. Terminal-shoot leaf samples were taken from five trees each of the Delicious, Rome, and Stayman varieties in 34 orchards. All leaf and soil samples were collected during a 3-week period in July.

Available nutrients were extracted from the soil samples by electrodialysis in dilute boric acid solution (1) and determined by standard methods. Leaf

Severe potash deficiency in the apple shoot at the right shows the short, slender growth and burned leaves characteristic of severe potash shortage. (Courtesy J. R. van Haarlem, Horticultural Experiment Station, Vineland, Ontario.)

samples were analyzed by the method of Toth and co-workers (2).

Fertility Status of Orchard Soils

Considerable variation was found in the fertility status of soils from the 78 orchards sampled (Table I). Samples taken from beneath the trees contained considerably more available potassium than those collected from the row middles. This is probably a result of the practice of ring fertilization under the trees. Where this condition exists, an occasional broadcast application of potassium fertilizer would improve the growth of legumes and other land cover in the row middles.

Unlike potassium, available calcium and magnesium were slightly higher in soil samples collected from row middles than in those taken beneath the trees. Many orchards were too acid for optimum tree growth, especially in the area beneath the limb-spread of the trees. This condition indicates a need for more lime beneath the trees.

The available phosphorus content in the soil of many orchards was very high, notably in those located in the Coastal Plains Province. Application of phosphatic fertilizers could be reduced in some of these and, where phosphorus is especially high, could be completely eliminated for several years without harmful effects on tree growth or fruit yield.

Nutritional Status of Trees

Leaf analysis is a useful tool for evaluating nutritional disturbances and deficiencies of fruit trees. It has the advantage of appraising the tree rather than soil upon which the tree is growing. In this study wide variations in percentage composition of each element determined occurred in the leaf sam-

TABLE I.—NUTRIENT STATUS OF TOPSOIL SAMPLES COLLECTED UNDER TREES AND ROW MIDDLES OF 78 NEW JERSEY APPLE ORCHARDS

Element	Sampling position	Average content lbs./acre	Medium nutrient level* lbs./acre	Percentage of 78 samples testing—		
				Low	Medium	High
Potassium	Under trees	145	100– 150	23.4	39.0	37.6
	Row middle	106		44.0	41.4	14.6
Magnesium	Under trees	129	75– 125	14.1	34.6	51.3
	Row middle	139		10.5	26.3	68.2
Calcium	Under trees	932	600–1200	37.2	26.8	36.0
	Row middle	1091		21.1	35.5	43.4
Phosphorus	Under trees	36	15– 30	25.6	23.1	51.3
	Row middle	37		29.0	22.4	48.6

		Percentage samples testing pH—				
		5.0 or less	5.1–5.5	5.6–6.0	6.1–6.5	6.6 or above
	Under trees	20	39	31	9	1
	Row middle	5	19	50	17	9

* Medium values used in classifying samples. Values below and above indicated medium values for each element were considered low and high, respectively.

ples (Table II). Approximately 11%, 4%, and 2% of the leaf samples had such low levels of potassium, magnesium, and nitrogen, respectively, that growers might expect tree improvement and higher fruit yields by applications of the deficient nutrients. Also, 21% of the samples were in a doubtful zone with respect to potassium and 45% with respect to magnesium. The trees in these orchards may be suffering from incipient deficiencies of these two elements. Approximately 42% of the leaf samples had such a high level of nitrogen as to indicate possible "excessive" use of this element.

Nutrient balance in apple trees is as important as the concentration of each of the necessary elements. A balance of all nutrients is necessary to maintain tree vigor and fruit yields. So an attempt was made to analyze the relationships existing among the nutrient elements determined in this study. Leaf samples that were high in nitrogen generally contained smaller amounts of potassium than those with low nitrogen levels. In contrast, for each 10% increase in leaf nitrogen, there was a corresponding increase of about 0.05% leaf magnesium. These are not new findings but they lend support to the concept of the need for proper balance among these three elements in orchard fertilization. It appears that heavy nitrogen fertilization tends to induce potassium deficiency and to increase the uptake of magnesium. Thus, potassium fertilizer may play a corrective role in instances where moderately heavy nitrogen fertilizers are applied.

Increasing concentrations of leaf calcium had no apparent influence on leaf potassium or magnesium. Only at luxury-utilization levels of leaf potassium was there any evidence of a depressing effect of potassium on leaf magnesium. Leaves with less than 0.13% phosphorus

TABLE II.—LEAF NUTRIENT STATUS OF APPLE TREES IN NEW JERSEY

Element	Variation % dry matter	% Samples* Falling in certain arbitrary ranges			
		Deficient	Doubtful	Ample	Excessive
Potassium	0.74–2.78	11.1	21.2	49.5	18.2
Magnesium	0.14–0.44	4.1	45.5	50.4	.....
Nitrogen	1.39–2.71	2.0	.....	56.2	41.8
		Low	Medium	High	
Phosphorus	0.10–0.30	18.3	67.4	14.3	
Calcium	0.52–2.10	11.1	22.6	66.3	
		Values** used for above classification were			
Potassium		<1.00	1.01–1.25	1.26–1.70	>1.71
Magnesium		<0.15	0.16–0.25	>0.26	.....
Nitrogen†		<1.60	....	1.61–2.20	>2.21
		<1.80	....	1.81–2.40	>2.41
Phosphorus		<0.13	0.14–0.20	>0.20	
Calcium		<0.72	0.78–1.00	>1.01	

* Total of 98 samples.
** Percentage values on dry-weight basis.
† Lower values for nitrogen used to classify Stayman and Rome variety samples, and upper values to classify Delicious samples.

An apple tree which received no fertilizer.

One fertilized with nitrogen only.

A tree which received complete fertilizer.

contained 2.28% nitrogen, whereas those with more than 0.21% phosphorus contained 2%. High concentrations of leaf phosphorus tended to be associated with high levels of leaf potassium and with low levels of leaf magnesium.

Relationship Between Leaf and Soil Potassium

Much attention has recently been given to the relationship between levels of available soil nutrients and their uptake by annual crops. But relatively less information is available regarding the relationship between fertility levels in soils and nutrient uptake by trees. Such information is necessary before soil-and-tissue-testing laboratories can make valid fertilizer recommendations to fruit growers. When the relationship between such tests has been more adequately established and correlated with tree response, some of the guesswork will have been eliminated.

A significant correlation was found between the available soil potassium and leaf potassium. When the influence of certain other available soil nutrients was considered, a much higher degree of correlation resulted between soil and leaf potassium ($R=0.69$). The potassium content of the tree leaves decreased markedly with increasing concentrations of available soil calcium plus magnesium. High levels of available soil phosphorus had similar effects as those of high calcium plus magnesium, but they were not so marked.

For proper interpretation of a test for soil potassium in an orchard, the soil's content of available calcium, magnesium, and phosphorus must be known. The depressing action of soil phosphorus on leaf potassium is of special importance. The 1951 survey of New Jersey orchards showed that many soils had very high phosphorus levels. On such soils high potassium levels are necessary for normal potassium uptake by apple trees.

The amount of available soil potassium influenced the magnesium content of leaves more than that of available magnesium in the soil. High concentrations of available soil potassium resulted in leaves of low magnesium. Where this situation exists, potassium fertilization should be discontinued until the level of this nutrient is brought into line with that of magnesium.

Little relationship was noted between soil pH and leaf levels of potassium. Soils with high concentrations of avail-

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Testing and Reclaiming Alkali Soils

By Warren R. Schoonover

Soils Specialist, University of California, Berkeley, California

METHODS of examining alkali soils have been better adapted to certain research needs than to the appraisal of field problems or as a guide to reclamation. It would seem unnecessary to have the conventional "complete" analysis of the soil extract and of the exchange complex in order to appraise most alkali problems and for determining a reclamation procedure. Any examination made, however, should be adequate to classify an alkali soil in relation to its most important characteristics. By definition, an alkali soil is one which contains either or both of:

(1) Soluble salts sufficient to impair plant growth;
(2) Adsorbed sodium, sufficient to impair plant growth either from direct toxicity or indirectly because of impaired soil structure.

A soil containing only soluble salts is said to be saline and has commonly been called a "white alkali" soil. A soil containing a substantial percentage of adsorbed sodium in the so-called exchange complex, either with or without substantial amounts of soluble salts, is an alkali soil which is different chemically and physically from one

Fig. 1. Variability in alkali impregnation as shown in cotton field.

which merely contains soluble salts. Soils of this kind often yield dark-colored extracts and may be called "black alkali" soils.

Principles of Reclamation

Alkali soils may be reclaimed under conditions of good drainage by two processes:

(1) Leaching to remove the excess soluble salts;

(2) Supplying soluble calcium to replace undesirable amounts of adsorbed sodium, which will change the black alkali to white alkali. The white alkali must then be leached out.

In some cases, calcium may be rendered available from insoluble sources, usually carbonates, present in the soil. Acids, acid-forming materials, or even carbon dioxide, produced deep in the soil by root respiration or by decay of organic matter, will dissolve calcium carbonate.

Classifying Alkali Soils

Alkali soils can be classified if a few simple facts are known, as follows:

(1) To what extent does the soil contain soluble salts?

(2) Is the soil dangerously low in available calcium? This characteristic is commonly expressed differently by saying a soil is bad if relatively high in adsorbed sodium. Soil clays have a great affinity for calcium. If much Ca^{++} is present in the soil solution, the exchangeable-sodium-percentage is bound to be low.

How to Appraise an Alkali Problem

Blocking Out the Problem—Soil Sampling:

Alkali soils being exceedingly variable (see Figure 1), samples should be taken to study the range of conditions rather than determine the average situation. Composite samples are not recommended. The most important portion of the profile to study is the top six inches or top foot, which will be the first soil occupied by the roots of plants in the alkali-sensitive seedling stage. Occasionally samples should be taken with suitable subdivisions clear down through the soil profile to hard-

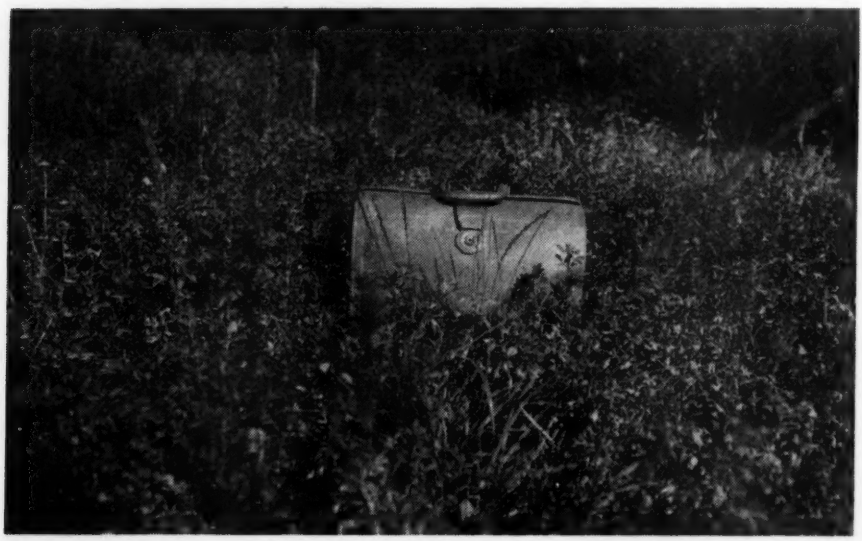

Fig. 2. Poor alfalfa growing in a soil of low salinity but with a Sol. Ca% about 2 in top foot.

Fig. 3. Medium alfalfa growing in a soil of low salinity, a Sol. Ca% of 30 or more in the top six inches but less than 1% in the second six inches and at lower depths.

pan, water table, or probable end of the root zone. The range of conditions to be studied is often indicated by variations in the growth of crop plants or weeds.

The amount of soil collected from one hole with a 3″ auger to a depth of 6″ is usually sufficient to make quick tests, with reserves for further study if desired. Samples should be collected in waterproof containers. They should be thoroughly air-dried and coarsely ground (2 mm or 10 mesh) to prepare for analysis.

Limit Analytical Work to Essentials:

Complete analysis of the salts and of the exchange complex of alkali soils is a

Fig. 4. Good alfalfa growing in a soil of low salinity with a Sol. Ca% around 40 to 50 in the top foot.

long and tedious procedure. Such analyses supply much information which is interesting but not useful for classifying soils or indicating treatment. Fortunately, three simple determinations will enable one to understand the nature of most alkali soils. These are:

(1) Estimating the soluble salt content by determining the specific electrical conductance of the extract from the saturated soil.

(2) Titration of soluble Ca^{++} or of soluble Ca^{++} plus Mg^{++} in this extract and caluculating the Ca or Ca+Mg as % of total cations estimated from the specific electrical conductance.

(3) A semi-quantitative, effervescence test for calcium carbonate.

The last test is not used to classify the soil but only to show whether or not it contains some calcium carbonate which may be made available.

Classes of Alkali Soils

Soils may be classified as follows, on the basis of these simple tests:

(1) *Saline or White Alkali Soils:* These merely contain soluble salts, including sufficient Ca^{++} or Ca^{++} plus Mg^{++}, to indicate a low sodium percentage in the exchange complex. CA^{++} or Ca^{++} plus Mg^{++} should constitute 30% or more of the estimated cations of soils in this class. Such soils should be reclaimable by leaching alone under conditions of good drainage.

(2) *Soils Low in Salinity but Low in Soluble-Calcium-Percentage:* Such a condition indicates high exchangeable sodium or other undesirable cations.[1] The high sodium soils include so-called black alkali soils.[2] The further the soluble calcium percentage falls below 30%, the worse the problem. Very bad soils have a Sol. Ca% below 5. Soils in Class (2) usually require treatment with a source of soluble calcium, followed by leaching, to effect reclamation.

(3) *Saline Alkali Soils Having Both High Salinity and Low Soluble Ca%:* Soils in this class usually need to be leached, treated with a source of soluble Ca^{++}, and leached again.

In contrast with these classes, we have normal soils in which conductance of saturation extracts will be below 2 millimhos/cm and often less than 0.5 mmhos/cm. Ca^{++} or Ca^{++} plus Mg^{++} will constitute more than 30% of the estimated soluble cation. Ca^{++} will usually be found to exceed Mg^{++} if the two are determined separately.

Relationship of Alkali to Plant Growth

Soluble Salts—White Alkali:

Much information has been published on the tolerance of crop plants for salinity. Some sensitive crops will be reduced materially in yield by the salts in soils showing a conductivity of the saturation extract as low as 2 mmhos/cm. Other crops may tolerate concentrations 10 times as great. Good soils show a conductance of the saturation extract of less than 2 mmhos/cm, mildly saline soils 2 to 6, moderately saline soils 6 to 12, strongly saline above 12. We have encountered field soils with conductivity of saturation extracts above 200 mmhos/cm.

Adsorbed Sodium—Black Alkali:

Figures 2, 3, and 4, show the effect of low soluble-calcium-percentage, which is closely coordinated with high

[1] We have used soluble-calcium-percentage as a criterion in classifying soils but calcium plus magnesium would do as well or better except in a few soils high in magnesium.

[2] This classification would include low Ca^{++} soils in which H^{+} is the undesirable cation. It is assumed one knows he is not dealing with such highly acid soils. Knowing the exact pH is of little help in classifying an alkali soil, but one should determine whether the reaction is acid or alkaline.

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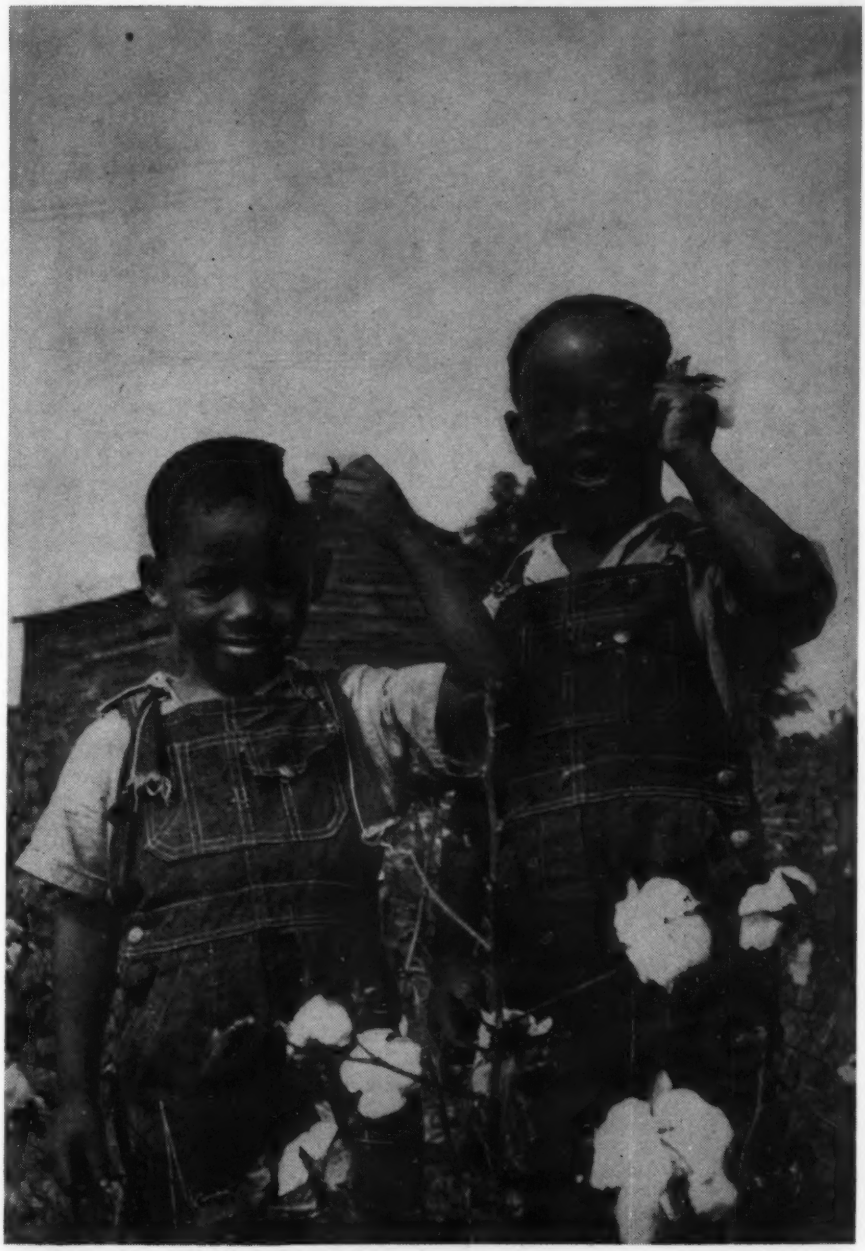

Beauty Hints!

Readying

for

Market

Changing

into

Autumn

The Old and the New

The Editors Talk

Our Cover Picture

The chemical testing of soils to determine their fertility status became an important consideration of soil scientists nearly 150 years ago. Various theories and methods were developed, tried out, and discussed (sometimes heatedly).

Well recognized today, it was early realized that the procurement of representative samples of soil for testing was a big—if not the biggest—factor in the accuracy and usefulness of the tests. It is of interest to note comments along this line in an article by S. W. Johnson which appeared in *The Cultivator* in August 1854—100 years ago.

"Admitting that a good analysis can be procured, have we evidence that it can be so carried out as to represent the composition of the soil? A farmer has several hundred acres of soil; how many analyses are needed 'to cover all this ground?' Often on a small farm, if we can judge by the look of the earth, there are a half dozen varieties. There are frequently decided variations within a very small area; and it rarely happens on farms that have been long under cultivation, that one specimen of soil represents the whole. The soil that is annually worked over by the plow is different from the undisturbed subsoil; and the latter may vary every few inches of its depth. How many analyses then must often be needed! But it is said—'collect from various parts of the field, and thus get an average.' This is but making bad, worse; for the analysis of such a mixture only represents the composition of the few pounds whch have been sent to the chemist; but not that of the millions of pounds that remain in the fields. In many cases—not indeed in all—the number of analyses that must be made renders the whole thing impracticable.

"But admitting the soil of the whole farm to be uniform in composition, what are the accidents that may vitiate analytical results? It may easily happen that an egg or snail shell lodge in the identical specimen of soil selected for analysis—then the carbonate of lime may come out too high. The droppings of a dog or bird will thus make a thousand acres rich in phosphates."

The big problem still with us today is, of course, the lack of homogeneity of soils, and many soil scientists have despaired of ever obtaining what may be called an accurate soil sample on any area larger than one square foot. In 1947, the National Soil and Fertilizer Research Committee was organized by memoranda of understanding between the states in each Land-Grant College Region, the Office of Experiment Stations, the Soil Conservation Service, and the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture. The Committee was directed to consider the national aspects of soils research, and to advise the Land-Grant College Association and the U. S. Department of Agriculture on soil, fertilizer, and irrigation research problems. It holds one meeting a year and carries on its continuing functions through the appointment of work groups. The Soil Test Work Group was appointed in July 1950 to study and summarize the current status of soil testing in the United

States and to submit recommendations concerning needed activities and improvements.

On page 13 of this issue, it is our privilege to present an article by the Soil Test Work Group on "Sampling Soils for Chemical Tests." Our cover picture is an illustration to accompany this article. The Work Group, after considering the best features of various procedures currently used, offers its suggestions for one which will give some degree of standardization in the taking of samples. With well over one million samples, exclusive of those sent to commercial laboratories, being tested annually in the United States, the importance of this study is obvious. Need for more research in this field is emphasized, the results of which cannot but help to increase our farmers' knowledge of the assets in their soil-bank accounts and the means of keeping those assets at a high level.

The Unit Cost of Production

The farmer is a businessman. In every sense he is a manufacturer. His major problems include costs of production, labor, and marketing. With a decrease in the prices of what he sells and an increase in what he must buy, the farmer is facing a situation common to the businessman.

In such a situation, a wise businessman looks first to his cost of production. From numerous official agricultural advisory sources, including the U. S. Department of Agriculture, the farmer has been urged to lower his production costs. The efficient use of fertilizer has been stressed. Now comes an observation from a group in position to speak on sound business practices—the bankers. The Ohio Bankers' Association has this to say:

> "Unit costs of production are important, particularly from the standpoint of withstanding price declines. Historically, farmers have tended to cut fertilizer expenditures in times of declining agricultural prices, and in most cases this is the most damaging type of economy they can practice. By reducing fertilizer applications and, consequently, reducing yields, the farmer pushes up his unit cost of production. In the face of declining agricultural prices, the individual farmer must not let rising unit production costs hurry him into red ink."

Not only does an adequate use of fertilizer affect unit cost of production by increasing yields; it plays an important role in labor and marketing problems. Greater yields per acre lessen labor costs by necessitating the use of less land to make crop goals, thus cutting planting, cultivating, and harvesting expenses. It improves marketability by giving produce a better finish and an improved shipping and keeping quality. In competitive selling fields, the product of highest quality demands the best prices and usually moves fastest.

Another big factor in the farmer's use of an adequate amount of fertilizer is that fertilizer is still one of the cheapest items he buys for his production. U. S. Department of Agriculture figures show that fertilizer is still the biggest bargain on the farm. Despite the fact that all prices paid by farmers are almost double what they were 12 years ago, fertilizer prices are up only half as much.

It therefore would appear to be sound business for the farmer to utilize to the fullest extent practicable that item in his production costs that is not only relatively the cheapest but one which produces a very high rate of return per dollar invested.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1927.....	20.2	20.7	101.9	109.0	85.0	119.0	10.29	34.83	....
1928.....	18.0	20.0	53.2	118.0	84.0	99.8	11.22	34.17	....
1929.....	16.8	18.3	131.6	117.1	79.9	103.6	10.90	30.92	....
1930.....	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931.....	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932.....	6.5	10.5	38.0	54.2	31.9	38.2	6.20	10.33	....
1933.....	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934.....	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935.....	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936.....	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937.....	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938.....	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939.....	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940.....	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941.....	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942.....	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943.....	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944.....	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945.....	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946.....	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947.....	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948.....	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949.....	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950.....	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951.....	37.9	51.2	163.0	306.0	168.0	211.0	19.50	69.30	....
1952									
September...	39.11	51.0	222.0	335.0	171.0	209.0	20.25	69.60	....
October.....	36.77	50.9	211.0	294.0	153.0	207.0	20.85	70.70	....
November...	34.05	47.6	217.0	311.0	145.0	213.0	21.25	69.70	....
December....	31.71	49.6	199.0	362.0	150.0	212.0	21.65	68.50	....
1953									
January.....	29.79	46.2	206.0	386.0	148.0	210.0	21.65	65.30	....
February....	30.19	36.7	179.0	384.0	143.0	205.0	20.85	64.50	....
March.....	31.52	....	165.0	401.0	146.0	210.0	19.65	63.60	....
April.....	31.45	....	134.0	409.0	146.0	208.0	18.85	63.10	....
May.....	31.73	51.5	115.0	413.0	149.0	206.0	17.95	61.80	....
June.....	31.51	51.0	102.0	398.0	146.9	188.0	16.05	61.20	....
July.....	31.87	51.2	95.5	402.0	147.0	187.0	15.45	59.00	....
August.....	32.77	51.3	91.4	350.0	148.0	186.0	15.85	56.70	....
Index Numbers (Aug. 1909—July 1914 = 100)									
1927.....	163	207	146	124	132	135	87	154	127
1928.....	145	200	76	134	131	113	95	152	154
1929.....	135	183	189	133	124	117	92	137	137
1930.....	77	128	131	123	93	76	93	98	129
1931.....	46	82	66	83	50	44	73	40	115
1932.....	52	105	55	62	50	43	52	46	102
1933.....	82	130	118	79	81	84	68	57	91
1934.....	100	213	64	91	127	96	111	146	95
1935.....	90	184	85	80	102	94	63	135	119
1936.....	100	236	164	106	163	116	94	148	104
1937.....	68	204	76	89	81	109	74	87	110
1938.....	69	196	80	79	76	64	57	97	88
1939.....	73	154	100	84	88	78	67	94	91
1940.....	80	160	78	97	96	77	64	96	111
1941.....	137	264	116	105	117	107	82	211	129
1942.....	153	369	168	134	143	124	91	202	163
1943.....	160	405	188	235	174	154	125	231	245
1944.....	167	420	214	216	170	160	139	234	212
1945.....	181	366	205	232	198	170	127	227	207
1946.....	263	382	178	248	212	209	141	319	182
1947.....	257	380	232	248	336	259	148	381	226
1948.....	245	482	222	253	201	226	155	298	214
1949.....	231	459	184	244	193	213	139	192	201
1950.....	323	517	132	197	238	226	141	384	185
1951.....	306	512	233	349	262	239	164	307	239
1952									
September...	315	510	319	382	266	236	171	309	182
October.....	297	509	303	335	238	234	176	314	189
November...	275	476	311	354	226	241	179	309	238
December....	256	496	286	412	234	240	182	304	256
1953									
January.....	240	462	296	440	231	238	182	290	237
February....	243	367	257	437	223	232	176	286	237
March.....	254	...	237	457	227	238	166	282	248
April.....	254	...	192	466	227	235	159	280	204
May.....	256	515	165	470	232	233	151	274	182
June.....	254	510	146	453	227	213	138	271	270
July.....	257	512	137	458	229	212	130	262	216
August.....	264	513	131	399	231	210	134	251	221

Wholesale Prices of Ammoniates

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1927	3.01	2.26	5.07	5.87	4.32	5.70
1928	2.67	2.30	7.06	6.63	4.92	6.00
1929	2.57	2.04	5.64	5.00	4.61	5.72
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952						
September	3.34	2.07	13.39	11.25	11.11	10.02
October	3.34	2.07	13.39	11.24	10.62	9.41
November	3.34	2.07	13.31	11.24	10.32	9.71
December	3.34	2.26	13.20	11.24	9.95	9.17
1953						
January	3.34	2.28	13.25	11.24	8.43	8.05
February	3.34	2.28	13.21	11.24	7.75	7.28
March	3.34	2.28	12.69	11.24	7.16	6.56
April	3.34	2.28	11.75	11.24	6.07	6.00
May	3.34	2.28	10.34	11.24	6.23	6.14
June	3.34	2.28	10.61	11.26	6.62	6.31
July	3.34	2.28	10.34	11.15	6.75	6.14
August	3.34	2.28	10.14	10.95	7.53	6.68
	Index Numbers (1910-14 = 100)					
1927	112	79	145	166	128	162
1928	100	81	202	188	146	170
1929	96	72	161	142	137	162
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952						
September	125	73	383	319	330	285
October	125	73	383	318	315	267
November	125	73	380	318	306	276
December	125	79	377	318	295	261
1953						
January	125	80	379	318	250	229
February	125	80	378	318	230	207
March	125	80	363	318	212	186
April	125	80	336	318	180	170
May	125	80	295	318	185	174
June	125	80	303	319	196	179
July	125	80	295	316	200	174
August	125	80	290	310	223	190

Wholesale Prices of Phosphates and Potash **

	Superphosphate, Baltimore, per unit	Florida land pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports[2]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports[2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports[2]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports[2]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1927	.525	3.09	5.50	.646	.924	25.55	.586
1928	.580	3.12	5.50	.669	.957	26.46	.607
1929	.609	3.18	5.50	.672	.962	26.59	.610
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952							
September	.860	3.98	5.47	.389	.768	14.72	.193
October	.860	3.98	5.47	.391	.768	14.72	.193
November	.860	3.98	5.47	.391	.768	14.72	.193
December	.860	3.98	5.47	.427	.827	16.00	.210
1953							
January	.860	3.98	5.47	.430	.827	16.00	.210
February	.860	3.98	5.47	.430	.827	16.00	.210
March	.860	4.22	5.47	.430	.827	16.00	.210
April	.860	4.28	....	.430	.827	16.00	.210
May	.860	4.28	....	.430	.827	16.00	.210
June	.860	4.28	....	.361	.708	13.44	.176
July	.895	4.28	....	.396	.768	14.72	.193
August	.895	....	....	.396	.768	14.72	.193
	Index Numbers (1910-14 = 100)						
1927	100	86	113	90	97	106	89
1928	108	86	113	94	100	109	92
1929	114	88	113	94	101	110	93
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952							
September	160	110	112	70	81	61	82
October	160	110	112	70	81	61	82
November	160	110	112	70	81	61	82
December	160	110	112	75	87	66	85
1953							
January	160	110	112	76	87	66	85
February	160	110	112	76	87	66	85
March	160	117	112	76	87	66	85
April	160	119	...	76	87	66	85
May	160	119	...	76	87	66	85
June	160	119	...	66	74	56	80
July	167	119	...	71	81	61	82
August	167	...	...	71	81	61	82

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and all Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1927.....	141	148	139	116	89	150	100	94
1928.....	149	152	141	121	87	177	108	97
1929.....	148	150	139	114	79	146	114	97
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	123	130	127	86	56	130	102	77
1942.....	158	149	144	93	57	161	112	77
1943.....	192	165	151	94	57	160	117	77
1944.....	196	174	152	96	57	174	120	76
1945.....	206	180	154	97	57	175	121	76
1946.....	234	197	177	107	62	240	125	75
1947.....	275	231	222	130	74	362	139	72
1948.....	285	250	241	134	89	314	143	70
1949.....	249	240	226	137	99	319	144	70
1950.....	256	246	236	132	89	314	142	72
1951.....	302	271	263	139	93	331	152	76
1952								
September.	288	271	250	145	98	349	160	74
October...	282	269	248	145	98	341	160	74
November.	277	268	248	144	98	336	160	74
December..	269	267	246	146	101	329	160	79
1953								
January...	267	267	246	144	102	307	160	80
February..	263	264	246	142	102	296	160	80
March....	264	265	248	141	102	282	160	80
April.....	259	264	246	139	102	256	160	80
May.....	261	264	247	137	102	245	160	80
June.....	259	260	246	135	102	253	160	70
July.....	259	261	248	138	102	252	167	75
August....	258	262	248	139	102	261	167	75

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] **Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.**

[2] **All potash salts now quoted F.O.B. mines only; manure salts since June 1941, other carriers since June 1947.**

** **The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period. The maximum discount is now 16%. Applied to muriate of potash, a price slightly above $.353 per unit K_2O thus more nearly approximates the annual average than do prices based on arithmetical averages of monthly quotations.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Fertilization of Field Crops in Arizona," Agr. Exp. Sta., Univ. of Ariz., Tucson, Ariz., Bul. 247, May 1953, W. T. McGeorge.

"Rate, Placement and Source of Nitrogen for Potatoes in Connecticut," Agr. Exp. Sta., Univ. of Conn., Storrs, Conn., Bul. 298, Mar. 1953, A. Hawkins and B. A. Brown.

"Boron Research at the Storrs Agricultural Experiment Station," Agr. Exp. Sta., Univ. of Conn., Storrs, Conn., Inf. 47, Feb. 1953, B. A. Brown.

"Foliar Nutrition Sprays on Vegetable Crops," Agr. Exp. Sta., Univ. of Del., Newark, Del., Bul. 295, Apr. 1953, E. P. Brasher, J. R. Wheatley, and W. L. Ogle.

"Annual Report, State Chemist of Florida, Year Ending December 31, 1952," Dept. of Agr., Chem. Div., Tallahassee, Fla., Jan. 1953.

"Results of Fertility Experiments in Jennings County," Agr. Ext. Serv., Purdue Univ., Lafayette, Ind., Mimeo. AY-120b, June 1952, G. H. Enfield.

"Tonnage of Commercial Fertilizer Reported by Manufacturers As Sold in Kansas in the Spring of 1953, by Counties, January 1, 1953 to June 30, 1953," State Bd. of Agr., Control Div., Topeka, Kan., Mimeo. 525, Aug. 17, 1953.

"Commercial Fertilizers for Winter Wheat in Relation to the Properties of Nebraska Soils," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Bul. 172, Jan. 1953, R. A. Olson and H. F. Rhoades.

"Fertilizer Sales by Grades in Order of Tonnage, Jan. 1953 to June 1953," State Dept. of Agr., Raleigh, N. C., Mimeo.

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Twenty-year-old Seed

AGRONOMISTS at the Ohio Agricultural Experiment Station have learned that a grain of corn can remain dormant for 20 years and still grow into a healthy vigorous plant when it receives the stimulating action of sun and soil.

In 1933, they sealed a handful of Clarage variety seeds in glass tubes and placed them under refrigeration at about 25 degrees. Moisture content of the corn was 11 per cent. This spring, the Agronomists broke open the tubes and found that 95 per cent of the kernels developed into normal plants.

J. D. Sayre, Physiologist at the Station, said the research is invaluable to plant breeders. Previous experiments with seed storage up to 5 years showed that breeders could by-pass annual production of foundation seed stocks. Controlling humidity by sealing seed away from air made this possible.

Sayre said there is no known record of successful corn seed storage for such periods as in this experiment. Now, he said, scientists are revising upward their estimate of how much vitality is stored in the tiny germ cell of a seed. Just what this germ cell contains that makes a seed sprout into a plant is still the biggest mystery of science.

Extra Dollars from Conservation

INVESTMENTS in conservation have returned an average of between 12 and 30 per cent in Illinois in the last 10 years.

Soil Conservation Service Economist Elmer L. Sauer of the University of Illinois explains the figures this way: Average net earnings for the last 10 years on "conservation" farms were $6.26 an acre higher than the average net earnings of "non-conservation" farms. The two groups of farms were evenly matched in everything except whether or not they had a conservation plan. Costs for the higher earnings on the "conservation" farms varied from $20 to $50 an acre.

"The costs sound high, but when figured as investments they give excellent returns," points out Sauer, who is in charge of research in conservation economics.

Some Relationships . . .

(*From page* 22)

able potassium produced leaves that were higher in phosphorus and lower in nitrogen than soils that were low in potassium. The negative relationship between soil potassium and leaf nitrogen indicates that growers cannot safely ignore the balance between these two elements in their fertilizer management programs. Potassium appears to be useful as a "safety-valve" to regulate the uptake of nitrogen by the trees.

Summary

Wide variations in fertility levels were found in a survey of 78 apple orchards in New Jersey. Soil from beneath limb-spread of trees contained more available potassium and less available calcium and magnesium, and it had a lower pH value than that from the row middles.

Below-optimum levels of potassium were found in 23.4% of the soil samples from beneath trees and in 44% of those from the row middles.

Analyses of leaves from Delicious, Rome, and Stayman trees in 34 orchards from which soil samples were taken showed that 11.1% of the trees were deficient in potassium and an additional 21.2% were in doubtful range.

Soil and leaf potassium were significantly related to each other. Leaves of trees growing on soils with high levels of calcium, magnesium, and phosphorus were low in potassium. When the depressing action of these three elements was taken into account, a much higher degree of correlation was found between soil and leaf potassium (R=0.69).

Orchard soils with high levels of available potassium produced leaves of lower magnesium and nitrogen and higher phosphorus contents than those with low potassium levels. Potassium apparently plays a significant role in the uptake of these three elements by trees.

Leaves with high levels of nitrogen contained less potassium and more magnesium than those with low amounts of this element.

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More Effective Fertilizer Use . . .

(*From page* 10)

of nitrogen and would double the nitrogen consumption for the Northeast. The survey shows that raising the current application of 10 pounds of nitrogen per acre on small grains to 40 pounds per acre would increase the yield more than 30 per cent. Several states reported similar increases for corn. On 1,880,000 acres of wheat an additional 28,000 tons of nitrogen would be required to go from the current 10 pounds of nitrogen to 40.

The average annual application of fertilizer P_2O_5 in this region ranges from 156 pounds for potatoes, 129 for vegetables, (30-40) corn and small grains to 7 for improved legume-grass and 5 pounds P_2O_5 per acre for permanent grass (7). Removal of P_2O_5 by forage crops is high. Three tons of dry forage analyzing 0.5% P_2O_5 contain and remove 30 pounds P_2O_5 per acre. Increasing the annual application of P_2O_5 from 7 to 40 pounds per acre on improved legume-grass mixtures along with adequate N, K, and best management would produce a 50% increase in yields.

The average annual application of fertilizer K_2O to improved legumes and

grass in this region is only 4 pounds per acre. Research information shows that 75 to over 200 pounds K_2O per acre are removed annually by high-yielding legume-grass mixtures. Some K_2O is supplied by the soil minerals and some by manure, but on many soils an addition of 100 to 150 pounds K_2O per acre each year is considered a minimum for high yields and maintenance of legume and desirable grass species. If the application of K_2O on 10 million acres of improved legume-grass forage were increased from 4 to 80 pounds per acre with adequate N and P, the forage yield would be increased 50%.

This increase would require the additional use of 380,000 tons of K_2O in the Northeast each year and would nearly triple current consumption of K_2O in this region. The P_2O_5 required to go from 7 to 40 pounds on 10 million acres would be 165,000 tons additional P_2O_5. Present use of phosphorus on all crops in the Northeast is roughly 300,000 tons P_2O_5. Thus to obtain a 50% increase in yield on the present acreage of improved legume-grass mixture in the Northeast would require about 165,000 tons P_2O_5 and 380,000 tons K_2O in addition to the current use (7).

The survey reveals that: (a) tremendous increases in the production of forage crops would result from a 5- to 10-fold expansion in the use of nitrogen, phosphorus, and potassium fertilizers; (b) the yield of small grain and corn would also be greatly increased by the use of additional nitrogen and potash; (c) additional nitrogen would produce smaller, though important increases in the yields of vegetables and potatoes; and (d) in contrast since current application of phosphorus and potash to potatoes is at a high level, increasing the rate of P_2O_5 or K_2O application would not produce important yield increases (Table II).

Large yield potentials do not mean overproduction of food

Although these data show the possibilities of much larger crop production through the proper use of fertilizers, the reader should not associate the tremendous yield potentials herein with overproduction of food. In addition to adequate fertilization, best systems of farm management and use of high-yielding varieties will be required for maximum crop production. The quantities of fertilizer required to approach these yields will not be available in the

Fig. 3. Unfertilized pasture on the left; fertilized pasture inside the enclosure at the right. Livestock apparently have a high regard for herbage grown with plenty of plant food.

next decade. While nitrogen fixation facilities are being expanded rapidly, increased production of phosphorus and potassium materials will be more difficult. The supply of fertilizer materials, especially phosphorus, appears inadequate to approach the tremendous crop yield potentials shown us by this survey. However, results from soil fertility experiments point the way to greater yields per acre, and it is hoped that these data will be made available to those farmers who are seeking effective ways to increase yields and lower production costs.

TABLE II.—EFFECTS OF CHANGING CURRENT APPLICATION OF PHOSPHORUS ON YIELD OF POTATOES AND VEGETABLE CROPS FOR THE 12 NORTHEASTERN STATES.*

Change in current use	Potato yield	Vegetable yield
−10%	−0.9%	−4%
−25%	−3.0%	−10%
Current use	156 lbs. P_2O_5/acre	129 lbs. P_2O
+10%	+0.7%	+3%
+25%	+1%	+8%

* (7)

Reduce phosphorus on potatoes and vegetables

The experimental data indicate the present use of phosphorus on potatoes and vegetables could be reduced without decreasing yields seriously, (Table II). Approximately 9,000 tons P_2O_5 could be diverted to other crops by a 10 per cent reduction and 22,000 tons P_2O_5 by a 25 per cent reduction in the present use of phosphorus on potatoes and vegetables in the Northeast.

Additional Research Needed

Large amounts of poultry manure, high in N, P, and K are wasted each year because of problems in transportation and handling. More efficient methods of handling manure from dairy cows are needed, since a large part of the liquid is lost down the drain.

More effective use of our current supplies of fertilizer materials will be required in the future for more efficient crop production. For example, many crops utilize only 10 per cent of applied superphosphate during the year of application. The present problem of making enough phosphate fertilizer might be solved for a few years if a system of soil management, which would double the present low efficiency of recovery of applied phosphorus, was used. The phosphorus saved by more effective use could be diverted to forage and other crops which at present receive one-fifth to one-tenth of the phosphorus required for high production.

More effective use of current supplies of fertilizer materials to obtain more efficient crop production will require full use of present basic and applied research data and increased research for additional fundamental knowledge of (a) factors affecting availability of fertilizer nutrients in the soil and (b) how plants feed on native, residual, and applied mineral nutrients. Although fundamental research in soil and plant relationships requires a vast amount of planning and effort, once fundamental truths have been uncovered this application can produce such far-reaching effects as the yield response of 1 bushel of corn for two pounds of applied nitrogen (8).

Summary

Most soils of the Northeast are acid, are low in nitrogen and phosphorus, and are low in potassium-supplying minerals. Research data on crop yield response to N-P-K show large potential yield increases through adequate use of fertilizers. However, unless liberal annual applications of N, P, and K are supplied, crop yields on most soils will be seriously reduced and the quality of vegetable, fruit, forage, etc. will be very low.

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Cattle and the Farm Economy . . .

(*From page* 12)

Stalk fields, stacked hay, straw stacks, and matured forage on permanent pastures provide useful sources of low-quality forage which breeding cows can use effectively when such forage is properly used. To feed a small allowance of an energy feed like corn along with 1 or 2 pounds of a high-protein feed like cottonseed meal makes it possible for mature cattle to utilize low-grade roughages. Sometimes stalk fields supply enough waste grain, beans, and grass seed for energy requirements. The protein supplement stimulates the appetites of the cattle and serves to give balance to the feed intake.

Quality Is a Big Factor

The cow-calf operator will manage his herd in such a way as to be able to sell his market calves or steers for the highest dollar. Higher values go with herd improvement. However, the brindle cow will do all right when the producer is alert enough to market his calves during that critical period when the calves have that necessary "bloom" and weight to command the price. If he allows calves from the brindle cows to go beyond the bloom stage, they lose grade. Never again will they bring the high dollar. When the bloom is lost, they must sell as stockers, and usually as plain stockers at that.

Here, then, is where the plain cow stands a chance to lose money for the owner. If he fails to sell just right, he loses. The man who buys these plain stocker calves gets the profit rather than the producer because he buys them cheap after the calves have lost several dollars a hundredweight. But, the producer has lost because he failed to market the calves when they were fat and ready. Calves out of plain cows, even though sired by good bulls, kill to advantage if in high bloom.

It's different for the cow-calf man who has a high-grade herd. He can handle his calf crop in many ways, all of which may be profitable. The point to remember is that calves out of the high-grade cows possess an inherent bred-in quality which the calves hold after weaning. They retain quality after they have lost their bloom. When high grades are fattened, they assume again that thickness and depth of fleshing and form which characterizes good beef.

Systems for Handling Calves

The producer with the high-grade herd can sell his calves at 500 pounds as feeders when weaned. If the calves were started on a creep before weaning, they may be continued on feed to sell as baby beeves. Or they may be strongly wintered, then put on top-

Fig. 3. These calves are making good daily gains on oat pasture in January.

quality, short-term pasture to sell as strong, fleshy feeders or killers in the early summer. Or, at the conclusion of the spring grazing period, they can go to dry lot and be fed 20 bushels of corn a head, then marketed as 900-1,000-pound choice-grade, slaughter steers during the fall months.

There is a real opportunity in the production of feeder cattle in the South. Freight costs from this area to the corn belt are much less than from the Western range area. But calves or yearlings offered as feeders must possess quality and breeding and have beef conformations. Corn-belt buyers in search of feeders will not take cattle of "mixed breeding" nor lower grades of calves or steers as a rule. They want quality cattle of standard colors, good conformation, and smoothness. They know that kind of cattle will make profitable use of the high-priced grain and grass they plan to put into them. They will take that kind of Southern cattle.

The Southern producer has not convinced himself on this angle. But he is thinking more about good cattle. When cattle values were at the recent high level, they did not show that extra premium on quality that now prevails. Producers then did not feel that a high-grade cow herd was so important. They felt that to save back top heifer calves to improve a grade herd, they were keeping calves that would bring the top of the market at weaning age. Even so each producer can with profit develop an improvement plan. The long-range opportunity, more producers are beginning to believe, is with the man with a top-quality cow herd.

Proof that quality is a paying proposition may be established in many ways. The differentials in prices of groups of calves marketed through feeder calf sales in this area show wide variations between the top selling groups and those which sell for the low dollar. Often it has been noted that as much as $15 to $18 a hundredweight exists between pens of calves that possess breeding, type, and conformation over plainly bred calves.

Producers who sell top lots of feeder calves put more in management, more in pastures and feed, but they sell cattle at higher values. Buyers pay producers well for their better calves. They want more like them.

Testing and Reclaiming . . .

(*From page* 26)

exchangeable-sodium-percentage, on the growth of alfalfa.

The alfalfa in Figure 4 continues to be good even though the subsoil from 12″ to 24″ has a Sol. Ca% about 5. Apparently alfalfa will do well if the percentage of divalent cations is sufficient in the first foot, provided water pentration is good enough so that the salts can be leached out.

We have studied soil samples taken around the roots of many crops. While there is great tolerance variation, we have found no crop which does well unless the Sol. Ca% is 10 or more in the top foot. Rice may be an exception since on the basis of limited data it seems to thrive where the condition is favorable only in the top six inches.

Appraising a Soil's Need for Calcium:

A common treatment for alkali soils low in calcium is the application of gypsum. It is easy to make a quantitative determination of the approximate gypsum requirement. This is done by treating five grams of soil [6] (or a volume contained in a small measuring scoop) with 100 ml. of saturated gypsum solution to see how much Ca^{++} will be taken out of the solution. Credit is given for Mg^{++} that is exchanged for Ca^{++} and added to the extract. The determination thus indicates how much Ca^{++} has been removed from the solution in exchange for Na^{+}. The equilibrium reaction runs nearly to completion since the amount of soil is small in relation to volume of gypsum solution. Unless the soil is very bad, the replacement of Na^{+} by Ca^{++} will be nearly quantitative.

If this determination is related to observed differences in plant growth in any field of fairly uniform soil texture, it is easy to let the growth serve as a guide to application rates. For example, the net gypsum requirement of the surface soil where alfalfa grew poorly, Figure 2, was about 11 tons per acre for the surface foot. This alfalfa was soon crowded out by alkali-resistant grass. Where the alfalfa was medium, Figure 3, the gypsum requirement was less than 500 pounds per acre for the top six inches and about 3 tons per acre for the second 6″ layer. The gypsum requirement was zero for the top foot of soil where the alfalfa shown in Figure 4 was growing.

Quick Tests for Alkali Soil:

It is evident that soils can be classified as to their alkali condition by two simple tests and if found to be low in available Ca^{++}, the need for this element can be appraised by another simple test. These tests are described briefly below:

(1) *Total Salts:* Prepare a saturated soil paste. Extract by suction. Test conductivity of extract with a Wheatstone bridge and express results in millimhos per centimeter. Studies on many alkali soils indicate that conductivity in mmhos/cm times 10 gives a fair approximation of concentration in milli-equivalents per liter.

(2) *Soluble Ca^{++}%:* Titrate soluble Ca^{++} and/or Ca^{++} plus Mg^{++} in a measured portion of the extract by the versenate method using murexide indicator for Ca^{++} and eriochrome black T for Ca^{++} plus Mg^{++}.[3, 4, 5]

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(3) *Gypsum Requirement Test:* Prepare a saturated solution of gypsum by shaking C.P. $CaSO_4 \cdot 2H_2O$ with distilled water. Let settle until clear, or filter. Determine Ca^{++} in me/1 using versenate titration and $Ca^{+}Mg$ indicator. The concentration should be about 30 me/1. Also record concentration as ml. of standard versenate required to titrate 5 ml.

Place 5 grams or one scoop [6] of the soil to be tested in a flask or bottle. Add exactly 100 ml. of the saturated gypsum solution. Stopper and shake at intervals for 10 minutes. Filter through a folded paper. Determine Ca^{++} plus Mg^{++} in a 5 ml. carefully pipetted aliquot using the versenate titration. The soil will adsorb calcium and exchange other cations for it, largely sodium and magnesium. Since the magnesium added to the extract from the soil is accounted for in the titration, the difference [7] between the Ca^{++} plus Mg^{++} found in the extract and the concentration of Ca^{++} in the saturated gypsum solution represents calcium which would be adsorbed to replace sodium under conditions of a plentiful gypsum supply (60 me. of Ca^{++} per 100 gr. of soil) and excess water. If it seems desirable to know how much Ca was adsorbed to replace Mg, titrate Ca only in another 5 ml. aliquot of the extract. The difference between Ca adsorbed to replace Na and total Ca in the gypsum solution adsorbed is Ca adsorbed to replace Mg.

[6] The scoop should hold 5 grams of soil of average density. The scoop we use holds 4 cc.

[7] Under some conditions, some of the difference may represent calcium precipitated because of the presence of Na_2CO_3.

Calculations are as follows:

A = ml. versenate to titrate Ca^{++} in 5 ml. of saturated gypsum solution.

B = ml. versenate to titrate Ca^{++} plus Mg^{++} in 5 ml. of soil extract.

C = ml. versenate to titrate Ca^{++} in 5 ml. of soil extract.

Since 100 ml. of saturated gypsum solution was used to extract 5 grams of soil, 5 ml. of extract is equivalent to 0.25 gr. of soil.

1. (A-B) (Versenate normality factor) 400 = me. of Ca^{++} adsorbed to replace Na^{+} (bases other than Mg^{++}) for each 100 gr. of soil.
2. (B-C) (Versenate normality factor) 400 = me. of Mg^{++} replaced by Ca^{++} in each 100 gr. of soil.

Calculate Gypsum Requirement:

Me/100 gr. equals equivalents per 100,000. The equivalent weight of pure gypsum $CaSO_4 \cdot 2H_2O$, is 86. 1 me/100 gr. = 86# per 100,000# of soil, or 1720# per 2,000,000#. 2,000,000# or 100 tons is about the weight of the top 6″ of an acre of soil, 1720# is 86% of a ton; therefore, to get the estimated gypsum requirement in tons per acre 6″, take 86% of the result in equation (1) above. Since high-grade gypsum is rarely 100% pure, and since the result arrived at by this method seems to be a minimum requirement, it may be advisable to count each me/100 gr. of Ca^{++} adsorbed to replace Na^{+} in equation 1, as equivalent to a ton of gypsum per A/6″. This is sufficiently accurate for reclamation requirements.

It is possible for this method to indicate that a soil has a negative gypsum requirement. Such a result means that the soil sample being tested contains a calcium salt more soluble than sulfate or a soluble magnesium salt.

When all of these determinations have been made, they can be set up in simple tabular form. The following table represents a situation in a field of cotton growing on a non-saline black alkali soil.

Condition cotton plants	Soil Sample depth inches	Cond. Sat. ext. mmhos/cm.	Est. cations me/1	Sol. Ca+Mg %	Net Gypsum requirement T/A6"	$CaCO_3$ present
Good.....	0– 6"	0.58	5.8	31	0	+
Good.....	6–12	0.52	5.2	23	0	++
Fair.....	0– 6	0.54	5.4	12	0.4	+
Fair.....	6–12	0.62	6.2	12	2.5	+++
Poor.....	0– 6	1.17	11.7	10	2.6	++
Poor.....	6–12	1.1	11.0	trace	4.4	+++
Bare spot....	0– 6	0.75	7.5	trace	2.9	++
Bare spot....	6–12	1.3	13.0	trace	8.8	+++

These determinations, which can be made quickly in a laboratory without much equipment, are adequate to appraise the conditions indicated by plant growth and to give a quantitative value for suggested treatment.

Sampling Soils . . .

(*From page* 18)

sticky soils.

(e) Be relatively easy to use in the field so as to provide for fairly rapid sampling of a field.

To consider briefly some of the sampling tools available or in use today:

Soil tubes—Various tubes have appeared on the market from time to time, many designed for soils of a certain area. Some have one side of the tube cut away for from 3 to 15 inches, except at the cutting head which involves two inches of solid tube of smaller bore. This type of tube is becoming very popular and certainly has many practical features.

Another type is the long, hollow tube, completely enclosed, with or without extension. These usually have a hardened steel cutting edge, the bore of which is less than that of the rest of the tube to prevent the soil core from sticking to the tube. The sample is removed by inverting the tube and pouring out the soil core. In certain soils this tube is quite useful. On the other hand it frequently gives trouble with sticky, tough soils, and may be very difficult to clean out. It is often useless with dry, sandy soils or with soils containing any quantity of rocks.

Soil Augers—These are of various types, some labeled "moist soil type," "dry soil type," "hard ground type," etc. Some involve extensions permitting sampling to greater depths. Many companies sell soil augers of one type or another. They are, of course, the traditional tool for soil classification and have been used successfully for routine sampling. The objection to the auger is that it is time-consuming and is difficult to use in dry, sandy soils. Also there is the possibility of contamination in withdrawing the auger from lower depths. In sampling pastures, an auger may actually remove a larger proportion of soil from below the surface than at the surface, due to the mechanical action of the auger, especially if the surface soil is dry. However, the auger is very useful in practical subsoil sampling.

Spades—These are widely used tools. Spades can be used for topsoil sampling, but it is essential to recognize the difficulty of obtaining constant volume from spot to spot and the trouble in confining the whole sample to a small volume. The spade is useful for profile examination and

Fig. 7. Here a ½-inch core is being taken from the slice (Fig. 6) to be placed in the bucket. This will be repeated at 15 to 20 places over the field. Then the soil in the bucket will be well mixed and enough soil taken out to fill a pint carton.

for subsoil examination and sampling.

Trowels—A well-constructed trowel with a narrow, curved blade can be a very desirable tool. It permits a small volume from each spot, is cheap, easily obtainable, and convenient to carry. For instance, O. W. Davidson of Rutgers has had made a special hand trowel that is of semicircular design and samples a small volume at each spot.

A partial list of companies offering soil-sampling tools for sale follows:

Soil Augers

American Instrument Co., Silver Spring, Md.
Arthur H. Thomas Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
H-W Manufacturing Co., Urbana, Ill.
Oakfield Apparatus Co., Box 65, Oakfield, Wis.
Soil-testing Equipment Co., Box 64, Station A, Ames, Iowa.

Soil-Sampling Tubes

American Instrument Co., Silver Spring, Md.
Arthur H. Thomas Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
LaMotte Chemical Products Co., Towson, Baltimore 4, Md.
Oliver Corporation, 400 W. Madison, Chicago, Ill.
Olson Management Service, 904 W. Stephenson St., Freeport, Ill.
Oakfield Apparatus Co., Box 65, Oakfield, Wis.

(4) Depth of Sampling

Almost all emphasis in soil sampling for routine chemical tests has been placed on the topsoil sample, which is usually taken at the plow depth, or

upper 5 to 6 inches, in fields that have been cultivated. It is obvious that the plants obtain some of the nutrients from lower depths, but in sampling soils one of the objectives is to sample the zone which is most likely to reflect past management rather than the feeding zone of the plant. Unfortunately there is very little information available on sampling of lower depths or the value of determinations made on such samples. Some instructions call for subsoil samples; others do not. Most workers agree that they have little basis for interpretation of data obtained from subsoil analyses. Since this is true, no instructions have been included for subsoil sampling except for alkali areas where information on salt accumulations and movement is helpful.

The omission of subsoil instructions in this study does not mean that they may not be of value. Some agronomists feel that the subsoil should be sampled and submitted to the laboratory if for no other reason than for examination for structure, texture, color, uniformity. These general physical observations may be helpful in making recommendations. In the case of orchards, samples from the lower depths are believed to be very useful, but special cases can be covered by additional instructions where needed.

In the case of permanent pastures and lawns, the instructions call for confining the sample to the upper two inches. This should not be taken to imply that grasses and legumes feed only in that area. Obviously they feed from lower depths also. The upper two-inch sample in this case is based on correlation of results of analyses with need for lime and fertilizer. Where lime and fertilizer are added on top by broadcasting, there is evidence that a better relationship exists between the analysis of the upper two inches and the plant-food requirements than can be obtained by analyzing to a depth such as six inches. If pastures are plowed or otherwise cultivated, these instructions would need to be qualified.

(5) Size of Sample and Subdivision

The average soil-testing laboratory calls for a volume of from one pint to one quart of soil. This may contain a certain amount of trash and rock material and when dried and prepared for analysis may amount to only half of this volume. Some instructions call for a small quantity of soil at each boring site in an effort to confine the entire composite to the pint-to-quart volume; others call for a composite amounting to several times this volume which is then mixed and subdivided.

There is always the likelihood of improper mixing in this case especially if the soil is damp. It would be preferable to avoid subdividing and to use a sampling tool that takes a relatively constant volume from each site so that the composite of all borings is included in the pint-to-quart volume. In practice this involves difficulties so that many instructions call for a composite sample whose total volume is from one to two quarts. This is thoroughly mixed by hand and from one-fourth to one-half of the total volume makes up the sample for analysis.

(6) Moisture Status

One other factor that deserves mention is the moisture status of the field when sampling soils. Little information is available on this. Most instructions do not recommend sampling fields that are very wet because of the inconvenience of sampling and because proper mixing of wet soils is difficult. In addition wet samples sent into the laboratory may easily be contaminated en route, and when they dry out in the container, may be difficult to handle. In spite of this, to avoid conflict with other farm work, it is sometimes necessary to sample fields too wet to plow. Such samples should not be dried artificially, but, if possible, allowed to air dry to a point where they can be broken up by hand and halved, if necessary.

All of the above points have been taken into consideration in combining

what are considered the best features of the various procedures in use today, in order to prepare the suggested sampling procedure which introduces this article. In conclusion it might be reiterated that while there is need for more research in soil-sampling procedures, it would be very helpful to those taking samples and following instructions if there were some standardization of sampling instructions among the various states and other soil-testing agencies. It is hoped that this can be accomplished by those using the composite sample method.

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Corn and Kine . . .

(*From page* 5)

to be said for beauty when utility and average yield were concerned, there is little or no record of such awakening. Everyone must praise the memory of the Holdens and their like for what they did to arouse and stimulate youth to listen and learn and go onward to find the truth.

The first explosive new theory to hit us was when Shull and East of New York and Connecticut did their first crossing of inbred corn in 1907 and then followed quickly with climactic announcements in 1909. Astounding as it was and upsetting to customary corn-breeding methods, the process of doing all the hand-pollinating seemed tedious, costly, and impracticable. Besides these pioneers in the new game, we had F. D. Richey of the Department of Agriculture, Dr. James Holbert of Illinois, Dr. D. F. Jones of Storrs, and Henry A. Wallace of Iowa. In a few crude experiments in the field the average run of inbred crosses failed to perform as predicted. The trouble was, as seen today, that they were looking for results from a large collection of inbred crosses. They had not tried to find out if certain single inbreds would cross to get desirable characteristics. That took a lot of funds and inexhaustible patience and voluminous records. It did not lend itself to mass cooperation by corn-growing farmers at that stage.

The first comprehensive, wholly impartial yield comparison of the new hybrid corn with the old open-pollinated kind was the Iowa corn yield test of 1921. Every farmer who desired could send in four pounds of his corn and a small entry fee. His corn with all the other samples in his own district would be planted and checked for yield. Done in the premier corn state of the nation, the announcements of the tests and the spotlight turned on hybrid selections set going a series of other trials that sped up the whole great shift in seed stocks we see today.

Thanks to farsighted experiment station directors and researchers, we now have adapted commercial strains of hybrid corn for every section of the Corn Belt, and the South has had a revolution in corn culture—thanks to hybrids and fertilizers to boost yield and maintain quality. This enhanced yield releases a lot of land poorly adapted to corn which may be taken out of cultivation and returned to the grass cover it originally enjoyed. Thus, better corn will transmit an indirect benefit to the livestock through better pastures and meadows, while at the same time adding much to the store of corn for direct feeding and mixing.

Are most species of livestock in the same place that show corn was before the hybrid breeders took hold of the situation? Except for dairying and poultry husbandry, the animal breeding field is yet bound up largely with show-ring excellence as against actual performance and utility. Form rather than function has been the rule too generally. True, we have beef progeny tests and a glimpse of higher carcass yield in the creation of new breeds of crossed hogs. Performance tests are making headway with poultry also. New production classes are being added to fair premium lists in dairy cattle. Encouraging signs of trail blazing are around us in the livestock breeding field, all of which makes us feel that corn's progress will be matched in a few years with equal progress on sounder methods for cattle and hogs.

With higher yielding strains of livestock established, we shall have greater efficiency in feeding. The farmer will get more for less land and labor in corn culture, and when he feeds that corn he will not be throwing so much of it away to inferiorly performing animals.

Poultrymen have advanced skill in their ability to make proper selections of high-producing pullets. In times past they used that skill in egg-laying contests to pick the best ones to send. This often made it a contest of cullers rather than of entire strains and flocks. Disease resistance is another vital factor that has been tackled with great vigor and excellent results in the Regional Poultry Laboratory at East Lansing, Mich.

Great strides toward a fairer and sounder breeding-record system have been made with dairy cows. Yet we find too many records not made under comparable conditions. In a cooperative enterprise of great value and magnitude, the Bureau of Dairy Industry and many states are making dam-daughter comparisons in proving bulls and then maintaining a very reliable index of all sires proved in dairy herd improvement units. Under our present conditions dairy breeding is a speculative process at best. Relief is not to be found either in purebreds as such or championships at the big fairs.

By actual breeding experiments, the Bureau of Dairy Industry has discovered and developed bulls which are "homozygous" for high productive qualities. These bulls have been "farmed out" in working herds and many of them have continued to prove that genes for high production will carry on into succeeding generations. The Bureau has also conducted some outstanding trials over five or six generations with breed crosses. These show that there is something besides pedigrees and show-ring records in attainment of consistently high production of milk and butter fat.

Left—untreated onion; Right—treated with MH-40

Naugatuck nips storage growth in bud!

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Purebred breeders of hogs and cattle have at times looked askance—or even worse—at the well-meant efforts of experimenters to establish systems that might interfere with their welfare. There has been a strong hint that some day the livestock breeders would be out of business. This idea is premature and probably unfounded.

IN the case of corn these days, the reverse is true. Farmers no longer attempt to produce their own supply of seeding ears. All go back time and time again to the manufacturers in mass production of hybrid corn. Their business is fortunately secure as long as they "do right by our Nell." Farmers have taken to the new scheme with alacrity and nary any complaint to speak of. They have stopped fooling around hunting good ears at random from wind-pollinated matings. They go each year to the corn breeding factories.

Today we hear much mention of the not distant time when hog growers for pork's sake will continually return to purebred breeders for their own foundation stock of sows and boars, and at the same time be using all the new facts of science. This visions a time when certain purebred breeders of hogs will maintain in "homozygous" form the foundation stock to furnish boars to the practical feed-lotter. Another group of breeders meanwhile will be in business to furnish in "homozygous" form line-bred sows which have been proved to combine well with the aforesaid strains of boars. That may be complicated as the deuce, but show us a single new advance in farming that isn't somewhat that way. Certainly hybrid corn production and improvement are anything but simple. Yet farmers everywhere see the light, acknowledge the debt owing to research, and stand ready to make it work as far as they are able, weather willing.

Having noted a few of these points

in passing, let's come to the last notch and frankly admit that environment and what we have to do with on the farm will often make or mar these projected breeding plans. Corn breeding and distribution are simple at best when compared with the things and forces a farmer must reckon with in raising a good crop. Likewise with livestock, wonders cannot be performed under adverse situations. Most of the thinkers we meet therefore believe that general all-around good farming practices are what count. The sum total of all the advisable practices which go to the making of a bumper crop or the making of a milk record are indispensable to success.

WE can go to the professional "piggery" or the nearest good "hatchery" and buy excellent specimens of improved hogs and poultry without doing all the detailed chores it takes to incubate and farrow the youngsters. That's progress of a practical kind, but it never releases the farmer who buys such starting stock from all the other important factors of environment which will affect the end result.

I am not one who fears the advent of "synthetic" farming or the ability of urban people to escape the food bills through hydroponic cropping. There is going to be enough detail work for a reduced number of farm hands and operators if they manage to feed a rapidly rising population.

Yet if science can lay hold fast on some of the imponderables that have balked successful farming enterprises and donate to agriculture a surer system of plant and animal production, with less loss and hazard, I am certain that it will be worth more than price supports or surplus removal. Having thus laid myself wide open for argument and disagreement, it's a good time to conclude—right when hybrid corn has boosted the 1954 crop over the three-billion-bushel mark, and there are not enough high-geared hybrid animals to consume it at a profit.

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The saleswoman at the perfume counter held out a small vial. "This brand," she said nonchalantly, "has proved quite effective. It has a chloroform base."

* * *

A red-headed Irish boy once applied for a position in a messenger office. The manager, after hiring him, sent him on an errand in one of the most fashionable districts. Half an hour later the manager was called to the phone and the following conversation took place:

"Have you a red-headed boy working for you?"

"Yes."

"Well, this is the janitor at the Oakwood Apartments, where your boy came to deliver a message. He insisted on coming in the front way and was so persistent that I was forced to draw a gun."

"Good heavens! You didn't shoot him, did you?"

"No, but I want my gun back."

* * *

An old Negro got up at revival meeting and said: "Brudders an' sisters, you knows an' Ah knows dat I ain't been what I oughter been. I'se robbed henroosts and stole hogs, and tole lies, and got drunk, an slashed folks wi' my razor and shot craps, and cussed an' swore; but Ah thank de Lord de's one thing Ah ain't nebber done; Ah ain't nebber lost mah religion."

Jack: "You know, drinking makes you look so beautiful."

Edith: "But I haven't been drinking."

Jack: "No, but I have."

* * *

The preacher was out on the golf course, and thought a small moral lesson might not be amiss.

Minister (timidly): "I notice that the players who get the lowest scores are not those who swear."

Gloomy Golfer (as he dug another slice of turf): "What the hell have they got to swear about?"

* * *

"Look," said the nurse to the brand-new father, "it's a male."

"Yes, I know," said the father, "but a male what?"

* * *

Quizzing a bunch of rookies, the sergeant asked, "Johnson, when you clean a rifle, what's the first thing you do?"

"Look at the number," the private answered promptly.

"Now what on earth has that got to do with anything?" the sergeant demanded.

"Just want to make sure," explained Johnson, "that I'm cleaning my own gun."

* * *

Asked: "Do you prefer monogamy or polygamy?" a film director said, "It all depends. In my own home, I like monogamy. But for the office, give me light oak every time."

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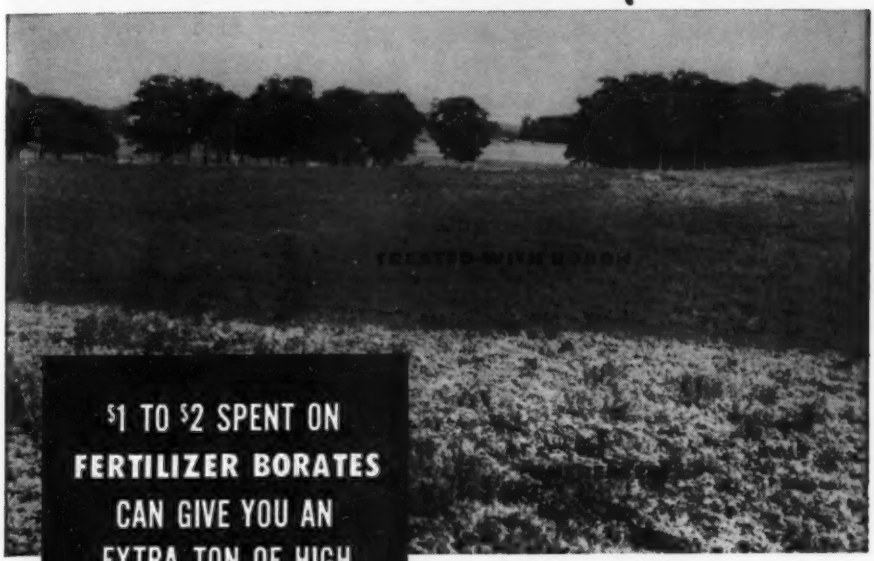

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3. LONGER LIFE STANDS

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FERTILIZER BORATE—HIGH GRADE, is an ore concentrate developed especially for fertilizer use. Because its water content is held to about 24% (5 mols) this material saves you money in costs of transportation, storage, handling, etc. Only 83 lbs of FERTILIZER BORATE HIGH GRADE is required for each 100 lbs. borax guaranteed in formulated mixtures. Available in two particle sizes; a fine mesh for adding to mixed fertilizers . . . a coarse mesh for direct application. County Agents or State Experimental Stations should be consulted for detailed recommendations.

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